Chapter 21

LAND TRAVEL

21-1. Introduction:

a. In any survival situation following an aircraft emergency, a decision must be made to either move or remain as close as possible to the parachute or crash site. In this chapter, land travel will be discussed and the various considerations that survivors should address before determining if travel is or is not a necessity.

b. Survivors may need to carry supplies and equipment while traveling to sustain life. For this reason, the techniques of backpacking and improvised packing are discussed to help a person do this task.

c. As a survivor, the ability to walk effectively is important in conserving energy and safety. Additionally, in rough terrain, travel may need to be done with the aid of a rope. The techniques of ascending and descending steep terrain are fundamental to understanding and performing rescue from rough terrain. These techniques, as well as techniques for snow travel, are covered. Travel may not be easy, but a knowledgeable traveler can travel safely and effectively while saving time and energy.

21-2. Decision to Stay or Travel. In hostile areas, the decision to travel is normally automatic. To stay in the vicinity of the crash or parachute landing can lead to capture. In friendly areas, a choice exists. The best advice is to stay with the aircraft. Most rescues have been made when downed aircrews remained with the aircraft.

a. Survivors should only leave the area when they are certain of their location and know that water, shelter, food, and help can be reached, or after having waited several days, they are convinced that rescue is not coming and they are equipped to travel.

b. Before making any decision, survivors should consider their personal physical condition and the condition of others in the party when estimating their ability to sustain travel. If people are injured, they should try to get help. If travel for help is required, they should send the people who are in the best physical and mental condition. Send two people if possible. To travel alone is dangerous. Before any decision is made, survivors should consider all of the facts.

(1) If the decision is to stay, these problems should be considered:

(a) Environmental conditions.

(b) Health and body care; camp sanitation.

(c) Rest and shelter.

(d) Water supplies.

(e) Food.

(2) If the decision is to travel: In addition to the primary survival problems of providing food, water, and shelter, the following must be considered:

(a) Direction of travel and why.

(b) Travel plan.

(c) Equipment required.

c. Before departing the site, survivors should leave information at their aircraft (nontactical situation only) stating departure time, destination, route of travel, personal condition, and available supplies.

d. From the air, it is easier to spot the aircraft than it is to spot people traveling on the ground. Someone may have seen the aircraft crash and investigate. The aircraft or parts from it can provide shelter, signaling aids, and other equipment (cowling for reflecting signals, tubing for shelter framework, gasoline and oil for fires, etc.). Avoiding the hazards and difficulties of travel is another reason to stay with the aircraft. Rescue chances are good if survivors made radio contact, landing was made on course or near a traveled air route, and weather and air observation conditions are good.

e. Present location must be known to decide intelligently whether to wait for rescue or to determine a destination and route of travel. The survivors should try to locate their position by studying maps, landmarks, and flight data, or by taking celestial observations. Downed personnel should try to determine the nearest rescue point, the distance to it, the possible difficulties and hazards of travel, and the probable facilities and supplies en route and at the destination.

f. There are a number of other factors that should be considered when deciding to travel.

(1) The equipment and materials required for cross-country travel should be analyzed. Travel is extremely risky unless the necessities of survival are available to provide support during travel. Survivors should have sufficient water to reach the next probable water source indicated on a map or chart and enough food to last until they can procure additional food. To leave shelter to travel in adverse weather conditions is foolhardy unless in an escape and evasion situation.

(2) In addition to the basic requirements, the physical condition of the survivor must be considered in any decision to travel. If in good condition, the survivor should be able to move an appreciable distance, but if the survivor is not in good condition or is injured, the ability to travel extended distances may be reduced. Analyze all injuries received during the emergency. For example, if a leg or ankle injury occurred during landing, this must be considered before traveling.

(3) If possible, survivors should avoid making any decision immediately after the emergency. They should wait a period of time to allow for recovery from the mental—if not the physical—shock resulting from the emergency. When shock has subsided survivors can then evaluate the situation, analyze the factors involved, and make valid decisions.

21-3. Travel. Once the survivors decide to travel, there are several considerations that apply regardless of the circumstances.

a. The ranking person must assume leadership, and the party must work as a team to ensure that all tasks are done in an equitable manner. Full use should be made of any survival experience or knowledge possessed by members of the group, and the leader is responsible for ensuring that the talents of all survivors are used.

b. Survivors should keep the body's energy output at a steady rate to reduce the effects of unaccustomed physical demands.

(1) A realistic pace should be maintained to save energy. It increases durability and keeps body temperature stable because it reduces the practice of quick starts and lengthy rests. More importantly, a moderate, realistic pace is essential in high altitudes in avoiding the risks of lapse of judgment and hallucinations due to lack of oxygen (hypoxia). Travel speed should provide for each survivor's physical condition and daily needs, and the group pace should be governed by the pace of the slowest group member. Additionally, rhythmic breathing should be practiced to prevent headache, nausea, lack of appetite, and irritability.

(2) Rest stops should be short since it requires added energy to begin again after cooling off. Survivors should wear their clothing in layers (layer system) and make adjustments to provide for climate, temperature, and precipitation. It is better to start with extra clothing and stop and shed a layer when beginning to warm up.

(3) Wearing loose clothing provides for air circulation, allows body moisture to evaporate, and retains body heat. Loose clothing also allows freedom of movement.

(4) Travelers should keep in mind when planning travel time and distance that the larger the group, the slower the progress will be. Time must be added for those survivors who must acclimate themselves to the climate, altitudes, and the task of backpacking. Survivors should also allow time for unexpected obstacles and problems which could occur.

(5) Proper nutrition and water are essential to building and preserving energy and strength. Several small meals a day are preferred to a couple of large ones so that calories and fluids are constantly available to keep the body and mind in the best possible condition. Survivors should try to have water and a snack available while trekking, and they should eat and drink often to restore energy and prevent chills in cold temperatures. This also applies at night.

21-4. Land Travel Techniques. Land travel techniques are based largely on experience, which is acquired through performance. However, experience can be partially replaced by the intelligent application of specialized practices that can be learned through instruction and observation. For example, travel routes may be established by observing the direction of a bird's flight, the actions of wild animals, the way a tree grows, or even the shape of a snowdrift. Bearings read from a compass, the Sun, or stars will improve on these observations and confirm original headings. All observations are influenced by the location and physical characteristics of the area where they are made and by the season of the year.

a. Route Finding. The novice should follow a compass line, whereas the experienced person follows lines of least resistance by realizing that a curved route may be faster and easier under certain circumstances. Use game trails when they follow a projected course only. For example, trails made by migrating caribou are frequently extensive and useful. On scree or rockslides, mountain sheep trails may be helpful. Game trails offer varying prospects, such as the chance of securing game or locating waterholes. Successful land travel requires knowledge beyond mere travel techniques. Survivors should have at least a general idea of the location of their starting place and their ultimate destination. They should also have knowledge of the people and terrain through which they will travel. If the population is hostile, they must adapt their entire method of travel and mode of living to this condition.

b. Wilderness. Wilderness travel requires constant awareness. A novice views a landscape from the top of a hill with care and interest, and says, "let's go." The experienced person carefully surveys the surrounding countryside. A distant blur may be mist or smoke; a faint, winding line on a far-off hill may be manmade or an animal trail; a blur in the lowlands may be a herd of caribou or cattle. People should plan travel only after carefully surveying the terrain. Study distant landmarks for characteristics that can be recognized from other locations or angles. Careful and intelligent observation will help survivors to correctly interpret the things they see, distant landmarks, or a broken twig at their feet. Before leaving a place, travelers should study their backtrail carefully. Survivors should know the route forward and backward. An error in route planning may make it necessary to backtrack in order to take a new course. For this reason, all trails should be marked (figure 21-1).

c. Mountain Ranges. Mountain ranges frequently affect the climate of a region and the climate in turn influences the vegetation, wildlife, and the character and number of people living in the region. For example, the oceanside of mountains has more fog, rain, and snow than the inland side of a range. Forests may grow on the oceanside, while inland, it may be semi-dry. Therefore, a complete change of survival techniques may be necessary when crossing a mountain range.

(1) Travel in mountainous country is simplified by conspicuous drainage landmarks, but it is complicated by the roughness of the terrain. A mountain traveler can

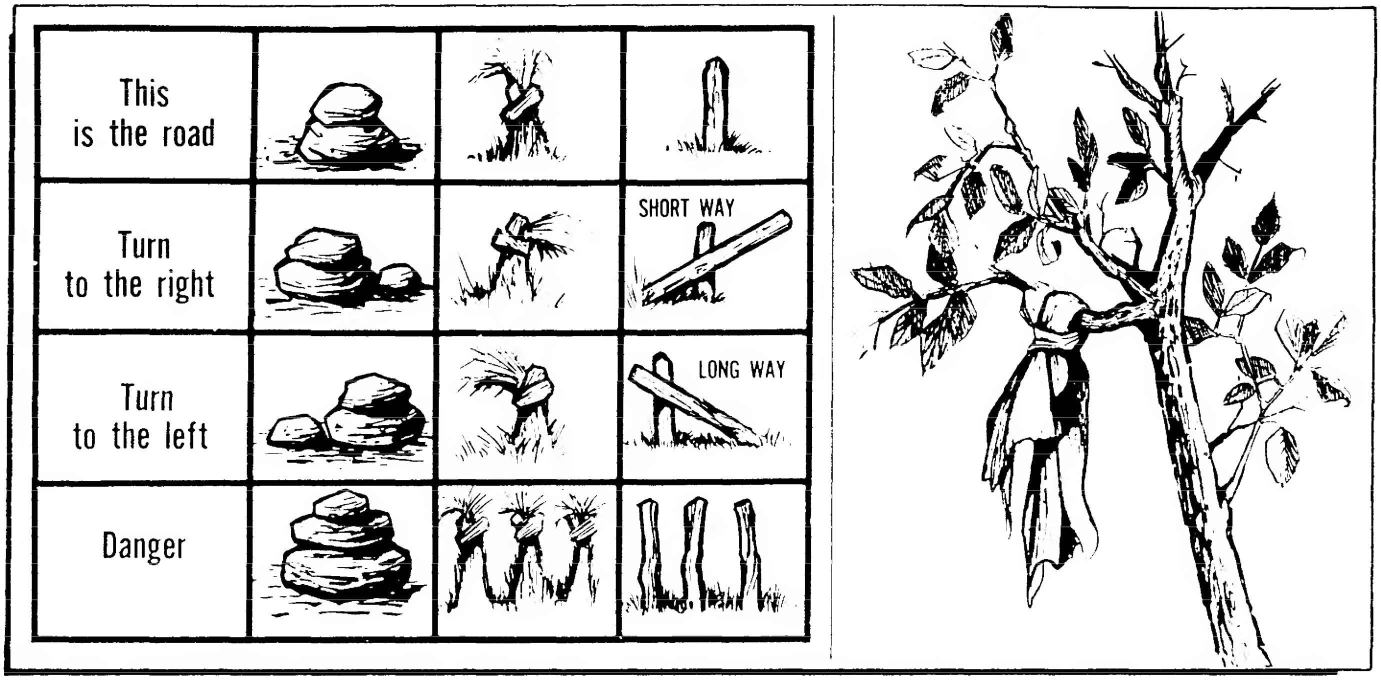


Figure 21-1. Marking a Trail.

readily determine the direction in which rivers or streams flow; however, surveying is necessary to determine if a river is safe for rafting, or if a snowfield or mountainside can be traversed safely. Mountain travel differs from travel through rolling or level country, and certain cardinal rules govern climbing methods. A group descending into a valley, where descent becomes increasingly steep and walls progressively more perpendicular, may be obliged to climb up again in order to follow a ridge until an easier descent is possible. In such a situation, rappeling with a parachute line rope may save many weary miles of travel. In mountains, travelers must avoid possible avalanches of earth, rock, and snow, as well as crevasses (deep cracks in the ice) in ice fields.

(2) In mountainous country, it may be better to travel on ridges—the snow surface is probably firmer and there is a better view of the route from above. Survivors should watch for snow and ice overhanging steep slopes. Avalanches are a hazard on steep snow-covered slopes, especially on warm days and after heavy snowfalls.

(3) Snow avalanches occur most commonly and freqently in mountainous country during wintertime, but they also occur with the warm temperatures and rainfalls of springtime. Both small and large avalanches are a serious threat to survivors traveling during winter as they have tremendous force. The natural phenomena of snow avalances is complex. It is difficult to definitely predict impending avalanches, but knowing general behaviors of avalanches and how to identify them can help people avoid avalanche hazard areas.

(a) Snow or Sluff Avalanche. The loose snow or sluff avalanche is one kind of avalanche that starts over a small area or in one specific spot. It begins small and builds up in size as it descends. As the quantity of snow increases, the avalanche moves downward as a shapeless mass with little cohesion.

(b) Terrain Factors Affecting Avalanches:

-1. Steepness. Most commonly, avalanches occur on slopes ranging from 30 to 45 degrees (60 to 100 percent grade), but large avalanches do occur on slopes ranging from 25 to 60 degrees (40 to 173 percent grade). (See figure 21-2.)

-2. Profile. The dangerous slab avalanches have more chance of occurring on convex slopes because of the angle and the gravitational pull. Concave slopes cause a danger from slides that originate at the upper, steep part of the slope (figure 21-3).

-3. Slopes. Midwinter snowslides usually occur on north-facing slopes. This is because the north slopes do not receive the required sunlight which would heat and stabilize the snowpack. South-facing slope slides occur on sunny, spring days when sufficient warmth melts the snow crystals causing them to change into wet, watery, slippery nowslidessnow. Leeward slopes are dangerous because the wind blows the snow into well packed drifts just below the crest. If the drifts have not adhered to the snow underneath, a slab avalanche can occur. Windward slopes generally have less snow and are compact. It is usually strong enough to resist move-

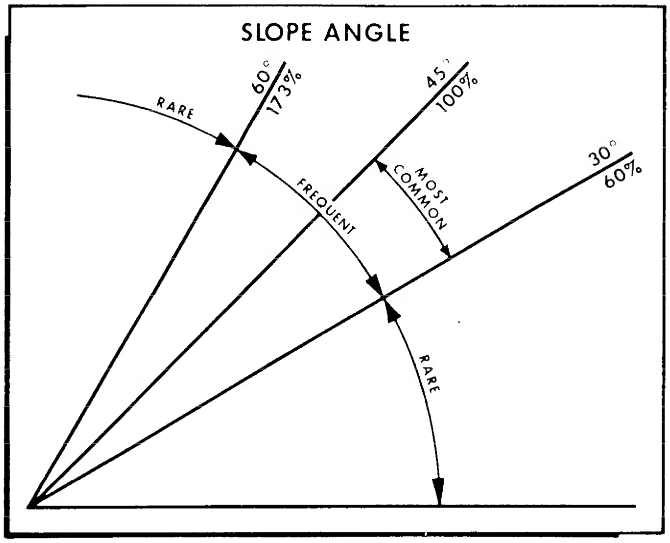


Figure 21-2. Slope Angle.

ment, but avalanches may still occur with warm temperature and moisture.

-4. Surface Features. Most avalanches are common on smooth, grassy slopes that offer no resistance.

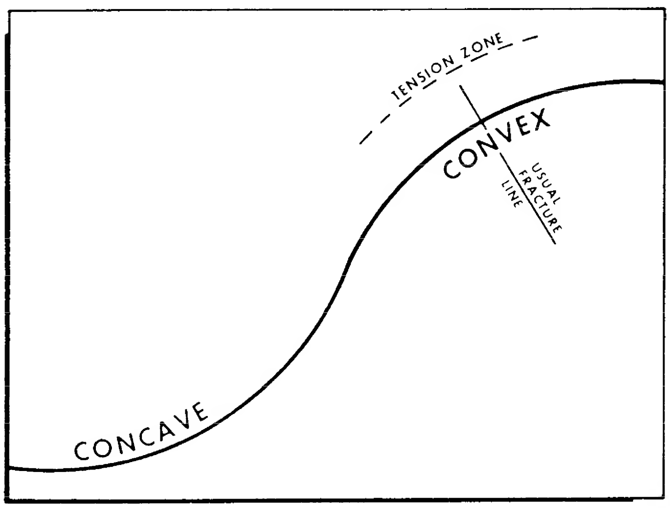


Figure 21-3. Profile of Slope.

Brush, trees, and large rocks bind and anchor the snow, but avalanches can still occur in tree areas (figure 21-4).

(c) Weather Factors:

-1. Old snow depth covers up natural anchors (rocks, brush, and fallen trees) so that the new snowfall slides easier. The type of old snow surface is important. Sun crests or smooth surface snows are unstable; whereas a rough, jagged surface would offer stability and an anchorage. A loose snow layer underneath is far more hazardous than a compacted one as the upper layer of snow will slide more easily with no rough texture to

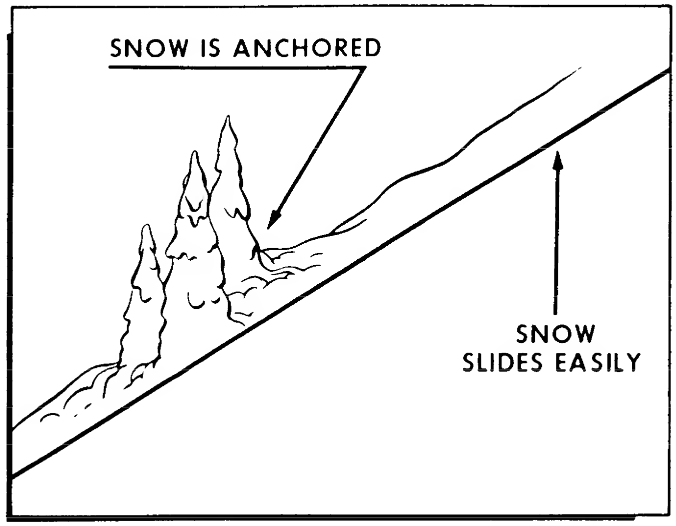


Figure 21-4. Snowslides.

restrain it. Travelers should check the underlying snow by using a rod or stick.

-2. Winds, 15 miles per hour or more, cause the danger of avalanches to develop rapidly. Leeward slopes will collect snow that has been blown from the windward sides, forming slabs or sluffs, depending upon the temperature and moisture. Snow plumes or cornices indicate this condition (figure 21-5).

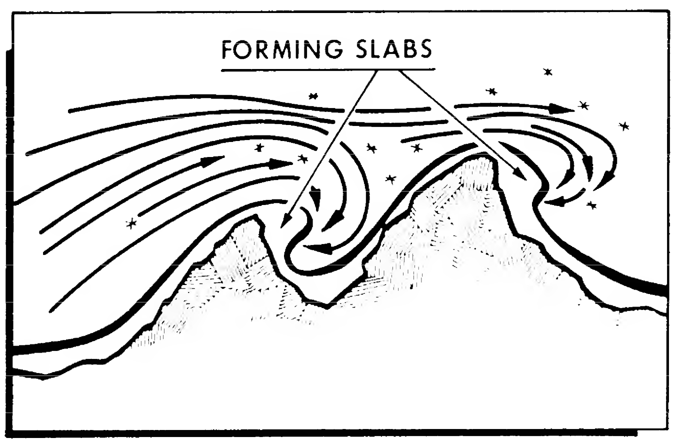


Figure 21-5. Forming Slides.

-3. A high percentage of all avalanches occur during or shortly after storms. Layers of different types of snow from different storms will cause unstable snow because the bond between layers will vary in strength. The rate of snowfall also has a significant effect on stability. A heavy snowfall spread out over several days is not as dangerous as a heavy snowfall in a few hours because slow accumulation allows time for the snow to settle and stabilize. A large amount of snow over a short

period of time results in the snow constantly changing and building up, giving it little time to settle and stabilize. If the snow is light and dry, little settling or cohesion occurs, resulting in instability.

-4. Under extremely cold temperatures, snow is unstable. In temperatures around freezing or just above, the snow tends to settle and stabilize quickly. Storms, starting at low temperature with light, dry snow which are followed by rising temperature, cause the top layer of snow to be moist and heavy, providing opportune conditions for avalanching. The light, dry snow underneath lacks the strength and elastic bondage necessary to hold the heavier, wetter snow deposited on top; therefore, the upper layer slides off. Also, extreme temperature differences between night and day cause the same problems. Rapid changes in weather conditions cause adjustments and movement within the snowpack. Survivors should be alert to rapid changes in winds, temperatures, and snowfall which may affect snow stability.

-5. Avalanches of wet snow are more likely to occur on south slopes. Sun, rainstorms, or warmer temperatures brought by spring weather are absorbed by the snow causing it to become less stable.

(d) Warning Signs. Avalanches generally occur in the same area. After a path has been smoothed, it's easier for another avalanche to occur. Steep, open gullies and slopes, pushed over small trees, limbs broken off, and tumbled rocks, are signs of slide paths. Snowballs tumbling downhill or sliding snow is an indication of an avalanche area on leeward slopes. If the snow echoes or sounds hollow, conditions are dangerous. If the snow cracks and the cracks persist or run, the danger of a slab avalanche is imminent. The deeper the snow, the more the terrain features will be obscured. Knowledge of common terrain features can help survivors visualize what they may be up against, what to avoid, and the safest areas to travel. Knowing the general weather pattern for the area is helpful. Survivors should try to determine what kind of weather will be coming by observing and knowing the signs that indicate certain weather conditions.

(e) Route Selection. If avoiding the mountains and avalanche danger areas is impossible, there are precautions survivors should take when confronting dangerous slopes. They should decide which slopes will be the safest by analyzing the factors that determine what makes one slope safe and another deadly. Study the slope terrain and keep in mind why avalanches occur.

-1. When survivors decide to cross a slope, one person at a time should cross. If all go together, they should not tie together since there is no way one person can hold another against an avalanche. Instead, they should tie a contrasting color line about 100 feet long (using suspension line or PLD tape) to each person. If they should get caught in an avalanche, the line will help identify their position if it is exposed. Survivors should select escape routes before and throughout the climb and keep these routes in mind at all times. They should also stay to the fall line (natural path an object will follow when falling or sliding down the slope) when climbing and not zig-zag or climb a different route because it seems easier. Staying to the fall line will prevent making fractures and at the same time, compact the snow, making it more stable for others who follow. If traversing, they should travel above the danger area. Survivors should travel quickly and quietly to avoid extended exposure to the probable danger of avalanches.

-2. If caught in an avalanche, any equipment that weighs survivors down should be dropped. The pack, snowshoes, and any other articles should be jettisoned.

-3. The standard rule is to use swimming motions to try to move towards the snow surface. Further, survivors should go for the sides and not try to out swim the avalanche. If near the surface, they should try to keep one arm or hand above the surface to mark their position. If buried, a person should inhale deeply (nose down) before the snow stops moving to make room for their chest. Trapped persons should try to make breathing space around their faces. They shouldn't struggle, but should relax and conserve their energy and oxygen. Only when fellow survivors or rescuers are nearby should the trapped individual shout. Rescue should be done as quickly as possible. Avalanche victims generally have a 50 percent chance of surviving after 30 minutes have passed because the snow will set up (harden).

-4. Glaciers may offer emergency travel routes across mountain ranges. Glacier crossing demands special knowledge, techniques, and equipment such as the use of a lifeline and poles for locating crevasses. There are many places where mountain ranges can be negotiated on foot in a single day by following glaciers. Survivors must be especially careful on glaciers and watch for crevasses covered by snow. If traveling in groups of three persons or more, they should be roped together at intervals of 30 to 40 feet. Every step should be probed with a pole. Snow-bridged crevasses should be crossed at right angles to their course. The strongest part of the bridge can be found by probing. When crossing a bridged crevasse, weight should be distributed over a large area by crawling or by wearing snowshoes.

-5. When forested areas are dense, river travel and ridges usually afford the easiest travel routes. In open forests, land travel is easier and offers a better selection of travel routes; however, such forests may not offer sufficient cover or concealment for escape and evasion travel.

-6. After a fire, windstorm, or logging operation, second-growth timber usually grows thick. It is worse after it grows about 20 feet high since any space between the trees is filled in by branches and the overhead timber isn't (yet) thick enough to cause the lower

branches to die from lack of sunlight.

-a. Deciduous brush also contributes to the overgrowth. Blowdowns, avalanche fans, and logging slush are difficult to negotiate. Such obstructions, even a few hundred feet may require major changes to the original travel route.

-b. Scrub cedar (subalpine fir) is hard to penetrate. There are tactics that can be used to make travel easier. Survivors can use fallen trees as walkways to provide a short route of travel through the scrub cedar to a clear area. Gloves should be worn when penetrating thorny vegetation. Overlaying bushes can be separated to allow passage. When land is steep, brush can be used to provide handholds if it is strong and anchored well.

-c. Brush can be dangerous. Survivors should be aware of the possibility of slipping while going downhill. Therefore, they should ensure each step is firmly placed. Survivors should be aware of travel difficulties presented by cliffs, boulders, and ravines which are covered by brush.

-7. Do not travel through dense brush if it can be avoided.

-a. Travel on trails rather than taking shortcuts through the brush. Brush is frequently easier to travel through (over) during the winter season when it is covered by snow and when snowshoes are available (improvised).

-b. During the summer, avoid avalanche tracks because the debris may be difficult to penetrate. Traveling on the "timber cones" between avalanche paths is best when climbing a valley.

-c. The heaviest timber is the best area to travel because little or no brush will be growing on the forest floor.

-d. Try to avoid areas near creeks and valley floors because they have more brush and trees than the valley walls and ridges. However, traveling in the stream channels may be preferable when the area is covered with dense brush and vegetation. Survivors may have to wade, but the stream may offer the best route through the brush.

-e. Traveling high above the brush at the timberline may be worthwhile if the bottom and sides of the valley look futile.

d. Snow and Ice Areas. Travel in snow and ice areas is not recommended except to move from an unsafe to a safe area, or from an area that has few natural resources to an area of greater resources (shelter material, food, and signaling area).

(1) Before traveling to a possible rescue site, town, village, or cabin, travelers should know their approximate position and the location of the desired site. The greatest hazard in snow and ice areas is the intense cold and high winds. Judging distance is difficult due to the lack of landmarks and the clear arctic air. Image distortion is a common phenomena. "White-out" conditions exist and the survivor should not travel during this time. A white-out condition occurs when there is complete snow cover and the clouds are so thick and uniform that light reflected by the snow is about the same intensity as that from the sky. If traveling during bad weather, great care must be taken to avoid becoming disoriented or falling into crevasses, over cliffs or high snow ridges, or walking into open leads. A walking stick is very useful to probe the area in the line of travel.

(2) Strong winds often sweep unchecked across tundra areas (due to the lack of vegetation) causing white-out conditions. Because of blowing snow, fog, and lack of landmarks, a compass is a must for travel, yet it is still difficult to navigate a true course since the magnetic variation in the high latitudes (polar areas) is often extreme.

(3) During the summer months, the area is a mass of bogs, swamps, and standing water. Crossing these areas will be difficult at best. Rain and fog are common. Insects such as mosquitoes, midges, and black flies can and will cause the survivor physical discomfort and may cause travel problems. If the body is not completely covered with clothing, or if survivors do not use a head net or insect repellant, insect bites may be severe and infection can set in.

(4) In mountainous country, it is often best to travel along ridge lines because it provides a firmer walking surface and there is usually less vegetation to contend with. High winds make travel impractical if not impossible at times. Glaciers have many hidden dangers. Glacial streams may run just under the surface of the snow or ice, creating weak spots, or they may run on the surface and cause slick ice. Crevasses which run across the glacier can be a few feet to several hundred feet deep. Quite often crevasses are covered over with a thin layer of snow, making them practically invisible. Survivors could fall into crevasses and sustain severe injuries or death. If glacier travel is required, it is best to use a probe pole to test the footing ahead.

(5) Summer travel in timbered areas should not present any major problems; however, travel on ridges is preferred since the terrain is drier and there are usually fewer insects. During the cold months, snow may be deep and travel will be difficult without some type of snowshoes or skis. Travel is generally easier on frozen rivers, streams, and lakes since there is less snow or wind-packed snow and they are easier to walk on.

(6) River and stream travel can be hazardous. Rivers comparatively straight are that way because of the volume of water flow and extremely fast currents. These rivers tend to have very thin ice in the winter (cold climates), especially where snowbanks extend out over the water. If an object protrudes through the ice, the immediate area will be weak and should be avoided if possible. Where two rivers and streams come together, the current is swift and the ice will be weaker than the ice on the rest of the river. Very often after freezeup, the

source of the river or stream dries up so rapidly that air pockets are formed under the ice and can be dangerous if fallen into. During the runoff months (spring and summer), rivers and streams usually have a large volume of water which is very cold and can cause cold injuries. Wading across or down rivers and streams should be done with proper footwear and exposure protection due to the depth, swiftness, unsure footing, and celdness of the water. Generally, streams are too small and shallow for rafting. Streams are often bordered by high cliffs or banks at the headwaters. As a stream progresses, its banks are often choked with alder, devil's club, and other thick vegetation making traveling very slow and difficult. Many smaller streams will simply lead the traveler to a bog or swamp where they end, causing more problems for the survivor.

(7) Sea ice conditions vary greatly from place to place and season to season. During the winter months, there is generally little open water except between the edges of floes. Crossing from one floe to another can be done by jumping across the open-water area, but footing may be dangerous. When large floes are touching each other, the ice between is usually ground into brash ice by the action of the floes against each other and this ground-up ice will not support a survivor's weight. Pressure ridges are long ridges in sea ice caused by the horizontal pressure of two ice floes coming together. Pressure ridges may be 100 feet high and several miles long; they may occur in a gulf or bay, or on polar seas. They must be crossed with great care because of the ruggedness of ice formations, weak ice in the area, and possibility of open water covered with a thin layer of snow or ground-up ice. During summer months, the ice surface becomes very rough and covered with water. The ice also becomes soft and honeycombed (candlestick ice) even though the air temperature may be below freezing. Traveling over sea ice in the summer months is very dangerous.

(8) Icebergs are great masses of ice and are driven by currents and winds; about two-thirds of the iceberg is below the surface of the sea. Icebergs in open seas are always dangerous because the ice under the water will melt faster than the surface exposed to the air, upsetting the equilibrium and toppling them over. The resulting waves can throw small pieces of ice in all directions. Avoid pinnacle-shaped icebergs—low, flat-topped icebergs are safer.

e. Dry Climates. Before traveling in the desert, the decision to travel must be weighed against the environmental factors of terrain and climate, condition of survivors, possibility of rescue, and the amount of water and food required.

(1) The time of day for traveling is greatly dependent on two significant factors; the first and most apparent is temperature, and the second is type of terrain. For example, in rocky or mountainous deserts, the eroded drainages and canyons may not be seen at night and could result in a serious fall. Additionally, manmade features such as mining shafts or pits and irrigation channels could cause similar problems. If the temperature is not conducive to day travel, survivors should travel during the cooler parts of the day (in early morning or late evening). Traveling on moonlit nights is another possibility; however, survivors must be aware that moonlight can cast deceiving shadows. This problem can be decreased by scanning the ground to allow the night sensitive portions of the eye time to pick up the slight differences in lighting. In hot desert areas where these hazards do not occur, traveling at night is a very practical solution. During the winter in the midlatitude deserts, the cold temperatures make day travel most sensible.

(2) There are three types of deserts: mountain, rocky plateau, and sandy or dune deserts. These deserts can present difficult travel problems.

(a) Mountain deserts are characterized by scattered ranges or areas of barren hills or mountains, separated by dry, flat basins. High ground may rise gradually or abruptly from flat areas to a height of several thousand feet above sea level. Most desert rainfall occurs at high elevations and the rapid runoff causes flash floods, eroding deep gullies or ravines and depositing sand and gravel around the edges of the basins. These floods are a problem on high and low grounds. The flood waters rapidly evaporate, leaving the land as barren as before, except for plush vegetation which rapidly becomes dormant. Basins without shallow lakes will have alkaline flats which can cause problems with chemical burns and can destroy clothing and equipment.

(b) Rocky plateau deserts have relief interspersed by extensive flat areas solid or broken rock at or near the surface. They may be cut by dry, steep-walled, eroded valleys, known as wadis in the Middle East and arroyos or canyons in the United States and Mexico. The narrower of these valleys can be extremely dangerous to humans and material due to flash flooding. Travel in these valleys may present another problem: a survivor can lose site of reference points and travel farther than intended. The Golan Heights in Israel is an example of a rocky plateau desert.

(c) Sandy (dune) deserts are extensive flat areas covered with sand or gravel. They are the product of ancient and modern wind erosion. "Flat" is relative in this case, as some areas contain sand dunes that are over 1,000 feet high and 10 to 15 miles long. Travel in such terrain depends on windward or leeward gradients of the dunes and texture of sand. These dunes help a survivor determine general direction. Longitudinal dunes are continuous banks of sand at even heights that lie parallel with the dominant wind. Other areas, however, may be totally flat for distances in excess of 2 miles. Plant life varies from none to scrub reaching over 6 feet. Examples of this desert include the ergs of the Sahara Desert, Empty Quarter of the Arabian Desert,

areas of California and New Mexico, and the Kalahari Desert in South Africa. A seif dune has forms similar to a drift behind a rock. Its length lies in the direction of the prevailing winds. Additionally, the horseshoe-shaped crescent dune has a hollow portion that faces downward. Ripples caused by wind in the sand may indicate the direction of the prevailing winds. These ripples generally lie perpendicular to the prevailing winds. In deserts, it is easier to travel on the windward side of the tops of dunes. Even though these ridges may not lay in a straight line and may wander, they offer a better route of travel than traveling in straight lines. A great deal of energy and time can be expended walking up and down dunes, especially in the loose sand on the leeward side of dunes.

(3) People who travel the desert at night orient themselves by the stars and Moon. Those who traveled by day use compasses, when available, and the Sun. Survivors should use all directional aids during emergency travel and each aid should be frequently cross-checked against each other. For desert travel, a compass is a valuable piece of equipment.

(a) Without a compass, landmarks must be used for local navigation. This can lead to difficulties. Mirages cause considerable trouble. Ground haze throughout the day may obscure vision. Distances are deceptive in the deserts and survivors have reported difficulty in estimating distances and the size of objects. In southern Egypt, one survivor reported large boulders always appeared smaller than they were and in other cases small obstacles appeared insurmountable. Survivors in Saudi Arabia and in Tunisia warned that it is difficult to maintain a single landmark in navigation. Several groups reported they found it necessary to take turns keeping an eye on a specific mountain, peak, or object which was their goal. Objects have a way of vanishing in some cases when the eye is moved for an instant, and in other cases, many peaks or hills looked alike and caused difficulties in determining the original object. In Tunisia, twin peaks are not reliable landmarks because of their frequent occurrence. (Survivors have found after a short time of traveling they may have up to a dozen twin peaks for reference in the same vicinity.) The Great Sand Sea (Egypt and Libya) was the emergency landing site of several groups of survivors and caused navigational difficulties. In these rolling sand hills, it is impossible to keep one object in view, and even footmarks fail to provide a reliable backtrail for determining travel directions. The extreme flatness of other stretches of desert terrain in North Africa also makes navigation difficult. With no landmarks to follow, no objectives to sight, survivors may walk in circles or large arcs before realizing their difficulties.

(b) A Marine pilot who made an emergency landing in the Arizona desert took the precaution of immediately spreading his parachute on the ground and putting rocks on the edges to ensure maximum visibility from the air. Then he decided to walk to his crashed plane, a distance he estimated to be 500 yards from his landing spot. He reached the plane and found it gutted by fire, and spent 5 days wandering the flat desert trying to find his parachute.

(c) Navigational difficulties of a different type may be experienced in Ethiopia, Kenya, and Somalia. Here the density of the thorn brush, even though it was primarily acacia with small leaves, makes it extremely hard to navigate from one point to another. In this area, survivors should follow animal trails and hope they lead to rivers or waterholes. Elephant trails seem to offer the best and clearest route.

(d) In the Sinai Desert area and in portions of Egypt, travel routes may be used; survivors can "stay put" on the trails. One survivor, who made a trail, encountered a camel caravan almost immediately, athough he reported it bothered him that he had not seen them approach, as they suddenly appeared out of a mirage. Another commented it was awfully hard to be alone in his section of the desert, for in every direction, he saw wandering tribes, camel herds, or people watching him. Two survivors independently suggested that survivors pay attention to the wind as an aid in navigation. One survivor, on the Arabian Peninsula, noted the wind blew consistently from the same direction. The other, in the Libyan Desert, made the same comment and said he was able to judge his direction of travel by the angle at which the wind blew his clothes or struck his body. Survivors in certain areas may orient themselves to the prevailing winds once it is established that these are consistent.

(4) People who walked across the North African deserts had much to say about the local environment and little of it was complimentary. The extreme temperatures bothered them most. It was extremely hot during the day and often bitter cold at night, especially during January and February.

(a) The bright sunlight was hard on their eyes, extremities, and exposed skin. The blinding effects of the Sun reflecting off the terrain caused many persons to express concern regarding sunglasses. Several built fires and smoked their goggles to obtain protection against the glare. Lenses alone do not adequately protect the eyes from glare. Sunglasses may be improvised to reduce this problem. Light-skinned individuals tended to sunburn faster and more severely than darker-skinned individuals. Some reported that no amount of previous suntanning seemed to make any difference. The heat affected their feet and hands. Survivors reported that the surface became so hot their feet were blistered through their shoes. Exposure of bare hands to the sunlight resulted in painful burns. Placing sunburned hands in bare armpits gave considerable relief since the armpits were one of the few places on the body where a person could find continuous perspiration to aid in cooling.

(b) The persistent winds of desert areas seem to provide no cooling effect, and several survivors found the constant blowing of the wind "got on their nerves." More significant is the fact that the constant winds usually carried an amount of sand or dirt particles. These particles got in eyes, ears, nostrils, and mouth and caused irritations which were often severe. Additionally, this persistent wind also caused earaches. One survivor reported that the abrasions of the eyes by the particles of dust reached a point where first the man's eyes watered so much that he could not see, and eventually the watering stopped and "emery cloth eyelids remained," making life miserable for him.

(c) Extreme winds blew sandstorms which lasted from a few minutes to months. Generally, survivors reported they could see the approach of such storms and were able to take proper precautions; however, sandstorms completely surprised a few groups and they had difficulty navigating. None of the survivors who experienced sandstorms in the northern desert underestimated the power and danger of such storms. Protection from the storms was uppermost in their minds. Most survivors used rock cairns, natural ledges, boulders, depressions, or wells for shelter. Survivors had time to dig depressions and rig a shelter from blankets, parachutes, or tarpaulins. A few wrapped themselves in their parachutes and endured the storm in a prone position.

(d) Nearly all of these people had some comment to make on orientation before, during, and after a sandstorm. They warned specifically that it is necessary to adequately mark the direction of travel before the storm. A few survivors said when the storm was over they had no idea which way they had been traveling and all their landmarks were forgotten, obliterated, or indistinguishable. The general plan for marking travel routes before a sandstorm is to place a stick to indicate direction. One survivor oriented himself with one rock a few feet in front of his position. He commented after the storm, that one point was not adequate and recommended using a row of stones, sticks, or heavy gear about 10 yards in length to give adequate direction following such an emergency.

(e) Several survivors reported they learned the hard way to keep their mouths shut in the desert. This meant breathing through the mouth caused drying and talking not only got on the other's nerves but also caused excessive drying of the mucous membranes.

(5) Mirages are common in desert areas. They are optical phenomena due to refraction of light by uneven density distribution in the lower layer of the air. The most common desert mirage occurs during the heat of the day when the air close to the ground is much warmer than the air aloft. Under this condition, atmospheric refraction is less than normal and the image of the distant low sky appears on the ground looking like a sheet of water. Distant objects may appear to be reflected in the "water." When the air close to the ground is much colder than the air aloft, as in the early morning under a clear sky, atmospheric refraction is greater than normal. When this condition occurs, distant objects appear larger and closer than they are and objects below the normal horizon are visible. Unless the density distribution in the lower layers is such that the light rays from an object reach the observer along two or more paths, they will see a distorted image or multiple images of the object.

(a) Reports of mirages were very common in the survival episodes examined. In most cases, they were recognized as mirages and only caused minor difficulties. No survivor reported these mirages actually represented bodies of water. While traveling, the survivor experienced problems as a result of mirages. Distances could not be judged because intermediate terrain was obscured by the mirage. Mirages hampered vision and navigation since it concealed objects. Additionally, mirages "magnified some objects and concealed others." One man hunting in the heat of the day reported that when he sighted an animal, it ran into or hid in a mirage. The lower layer of hot air which causes the mirage, commonly called desert haze, hampers vision and distorts objects. Signaling difficulties resulted from this since sighting a reflection on an object was apparently very difficult due to the low haze on the desert.

(b) Several survivors reported cases of imaginary illusions which were due to the haze or mirages. One group looked for a hill, for a viewpoint, so long that the entire party began to see hills in all directions. They finally held a conference to iron out their difficulties and all settled on one hill which the group should approach. Everyone in the party saw the hill, and the group walked an estimated 9 miles looking for the hill which never existed and which eventually disappeared into the desert flatness. Dawn and dusk illusions also occurred and were reported in the survivors' stories. One group was severely troubled with the false-dawn spectral light on the western horizon. The fact that the Sun at first appeared to be rising in the west caused anxious moments. Another party had one person who claimed he saw a flashing beacon on the evening horizon. The pilot explained the illusion as the occasional refraction of bright starlight near the horizon, through the residual heat waves of the cliff before them. But one crewmember was so convinced it was a beacon that he started walking to investigate this object and was never seen again.

(6) The following are manmade characteristics of the desert:

(a) Roads and trails are scarce in the desert, as complex road systems are not needed. Most existing road systems have been used for centuries to connect centers of commerce or important religious shrines, such as Mecca and Medina in Saudi Arabia. These roads are now supplemented by routes for transporting oil or other mineral deposits to collection points. Rudimentary trails exist in many deserts for caravans and nomadic tribesmen. These trails have wells or oases ap-

proximately every 20 to 40 miles, although there are waterless stretches of over 100 miles. These trails vary in width from a few yards to over 800 yards. Vehicle travel in mountainous desert terrain may be severely restricted. Available routes may be easily blocked by hostile people or climatic conditions. Passes may be blocked by snow in the winter. The travel distance on foot or by animal between two points in the mountains may be less than a tenth of the distance required if vehicles are used to make the trip.

(b) Apart from nomadic tribesmen who live in tents, desert inhabitants live in thick-walled structures with small windows, usually built of masonry or a mud and straw (adobe) mixture. The ruins of earlier civilizations are scattered across the deserts. Ancient posts and forts invariably command important avenues of approach and frequently dominate the only available passes in difficult terrain. Control of these positions may be imperative for forces intent on dominating the immediate area.

(c) Exploration for and exploitation of natural resources, of which oil is the best known, occurs in many desert areas, especially the Middle East. Wells, pipelines, refineries, quarries, and crushing plants may lead a survivor to rescue or captivity. Additionally, pipelines are often elevated, making them visible from a distance.

(d) Many desert areas are irrigated for agricultural and habitation purposes. Agriculture and irrigation canals are signs which can lead a survivor to people.

f. Tropical Climates. The inexperienced person's view of jungle travel may range from difficult to nearly impossible. However, with patience and good planning, the best and least difficult route can be selected. In some cases, the easiest routes are rivers, trails, and ridge lines. However, there may be hazards associated with these routes.

(1) Rivers and streams may be overgrown making them difficult to reach and impossible to raft. These waterways may also be infested with leeches. Trails may have traps or animal pits set on them. Trails can also lead to a dead end or into thick brush or swamps. Ridges may end abruptly at a cliff. The vegetation along a ridge may also conceal crevices or extend out past cliffs, making the cliff unnoticed until it's too late.

(2) The machete is the best aid to survival in the jungle. However, survivors should not use it unless there is no other way. They should part the brush rather than cut it if possible. If the machete must be used, cut at a down-and-out angle, instead of flat and level, as this method requires less effort.

(3) Survivors should take their time and not hurry. This allows them to observe their surroundings and gives better insight as to the best route of travel. Watch the ground for the best footing as some areas may be slippery or give way easily. Avoid grabbing bushes or plants when traveling. Falling may be a painful experience as many plants have sharp edges, thorns, or hooks. (NOTE: Wear gloves and fully button clothes for personal protection.)

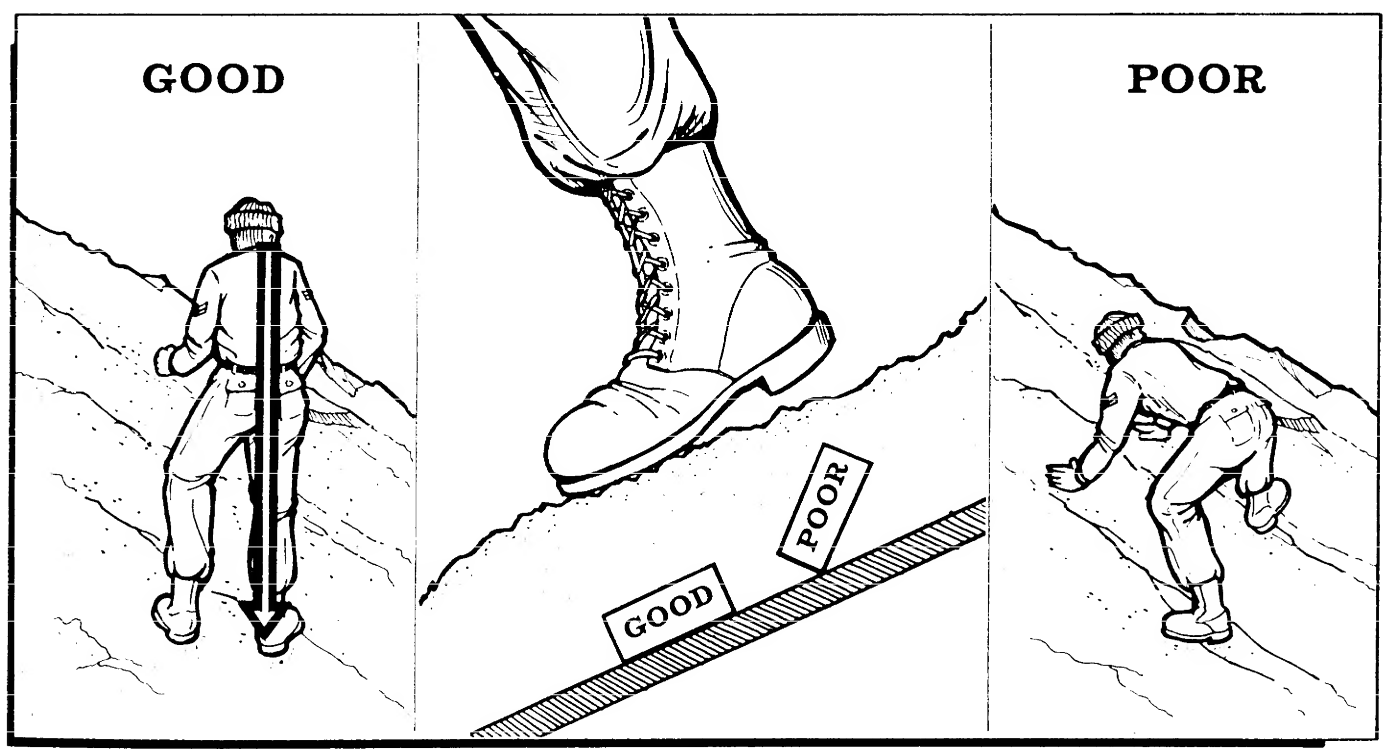


Figure 21-6. Weight of Body Over Feet.

(4) Quicksand can be a problem. In appearance, quicksand looks just like the surrounding area with an absence of vegetation. It is usually located near the mouths of large rivers and on flat shores. The simplest description of quicksand is a natural water tank filled with sand and supplied with water. The bottom consists of clay or other substances capable of holding water. The sand grains are rounded, as opposed to normal sharper-edged sand. This is caused by water movement which also prevents it from settling and stabilizing. The density of this sand-water solution will support a person's body weight. The danger if a survivor panics may be drowning. In quicksand, the survivor should use the spread-eagle position to help disperse the body weight to keep from sinking and a swimming technique to return to solid ground. (NOTE: Remember to avoid panicking and struggling, and spread out and swim or pull along the surface.)

21-5. Mountain Walking Techniques. Depending upon the terrain formation, mountain walking can be divided into four different techniques—walking on hard ground, walking on grassy slopes, walking on scree slopes, and walking on talus slopes. Included in all of these techniques are two fundamental rules which must be mastered in order to expend a minimum of energy and time. These fundamentals are: The weight of the body must be kept directly over the feet (figure 21-6), and the sole of the boot must be placed flat on the ground (figure 21-6). These fundamentals are most easily accomplished by taking small steps at a slow steady pace. An angle of descent which is too steep should be avoided and any indentations or protrusions of the ground, however small, should be used to advantage.

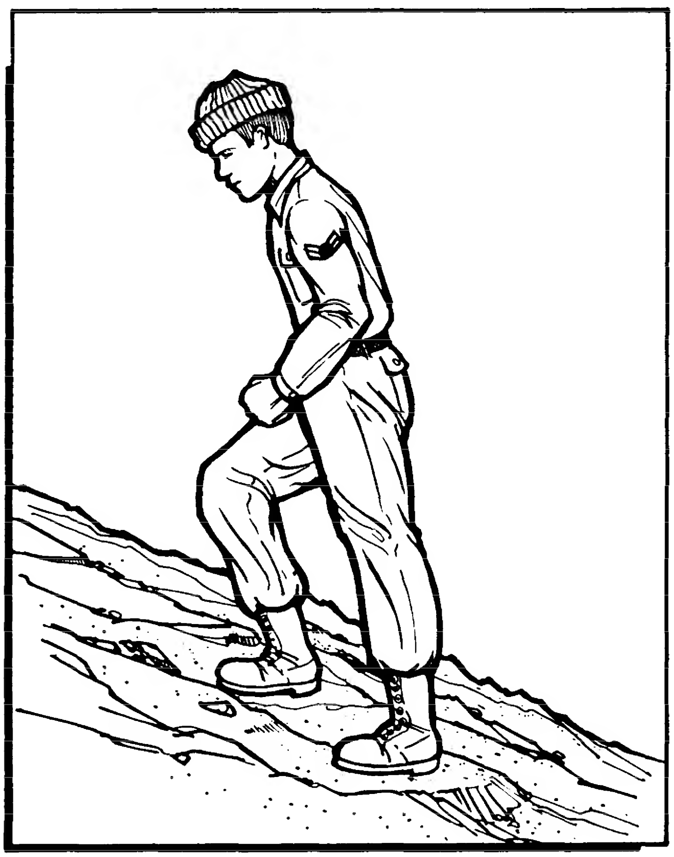


Figure 21-7. Locking Knees.

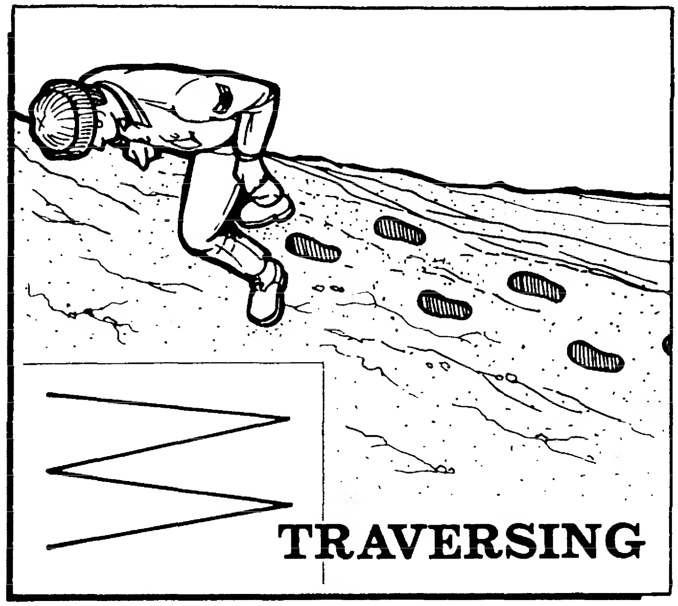


Figure 21-8. Traversing.

a. Hard ground is usually considered to be firmly packed dirt which will not give way under the weight of a person's step. When ascending, the above fundamentals should be applied with the addition of locking the knees on every step in order to rest the leg muscles (figure 21-7). When steep slopes are encountered, they can be traversed easier than climbed straight up. Turning at the end of each traverse should be done by stepping off in the new direction with the uphill foot (figure 21-8). This prevents crossing the feet and possible loss of balance. In traversing, the full sole principle is done by rolling the ankle away from the hill on each step. For narrow stretches, the herringbone step may be used; that is, ascending straight up a slope with toes pointed out (figure 21-9) and using the principles stated above. Descending is usually easiest by coming straight down a slope without traversing. The back must be kept straight and the knees bent (figure 21-10) in such a manner that they take up the slack of each step. Again, remember the weight must be directly over the feet, and the full sole must be placed on the ground with every step.

b. Grassy slopes are usually made up of small tussocks of growth rather than one continuous field. In ascending, the techniques previously mentioned are applicable; however, it is better to step on the upper side of each tussock (figure 21-11) where the ground is more level than on the lower side. Descending is best done by traversing.

Figure 21-9. Walking Uphill.

c. Scree slopes consist of small rocks and gravel which have collected below rock ridges and cliffs. The size of the scree varies from small particles to the size of a fist. Occasionally, it is a mixture of all size rocks, but normally scree slopes will be made up of rocks the same size. Ascending scree slopes is difficult, tiring, and should be avoided when possible. All principles of ascending hard ground apply, but each step must be picked carefully so the foot will not slide down when weight is placed on it. This is best done by kicking in with the toe of the upper foot so a step is formed in the scree (figure 21-12). After determining the step is stable, carefully transfer weight from the lower foot to upper and repeat the process. The best method for descending scree is to come straight down the slope with feet in a slight pigeon-toed position using a short shuffling step with the knees bent and back straight (figure 21-13). When several climbers descend a scree slope together, they should be as close together as possible, one behind the other, to prevent injury from dislodged rocks. Since there is a tendency to run down scree slopes, care must be taken to ensure that this is avoided and control is not lost. By leaning forward, one can obtain greater control. When a scree slope must be traversed with no gain or loss of altitude, use the hop-skip method. This is a hopping motion in which the lower foot takes all the weight and the upper foot is used for balance.

d. Talus slopes are similar in makeup to the scree slopes, except the rock pieces are larger. The technique of walking on talus is to step on top of, and on the uphill side of, the rocks (figure 21-14). This prevents them from tilting and rolling downhill. All other previously mentioned fundamentals are applicable. Usually, talus is easier to ascend and traverse, while scree is a more desirable avenue of descent.

21-6. Burden Carrying. Backpacking is essential when heavy loads must be carried for distances. Using a suitable harness and following certain approved packing and carrying techniques can eliminate unnecessary hardships and help in transporting the load with greater safety and comfort. Carrying a burden initially creates mental irritation and fatigue, either of which can lower morale. Survivors should keep their minds occupied with other thoughts when packing a heavy load. Adjustments should be made during each rest stop to improve the fit and comfort of the pack. Additionally, the rate of travel should be adjusted to the weight of the pack and the environmental characteristics of the terrain being crossed.

a. Burden carrying is a task that must be done in most survival environments. Often survivors must quickly

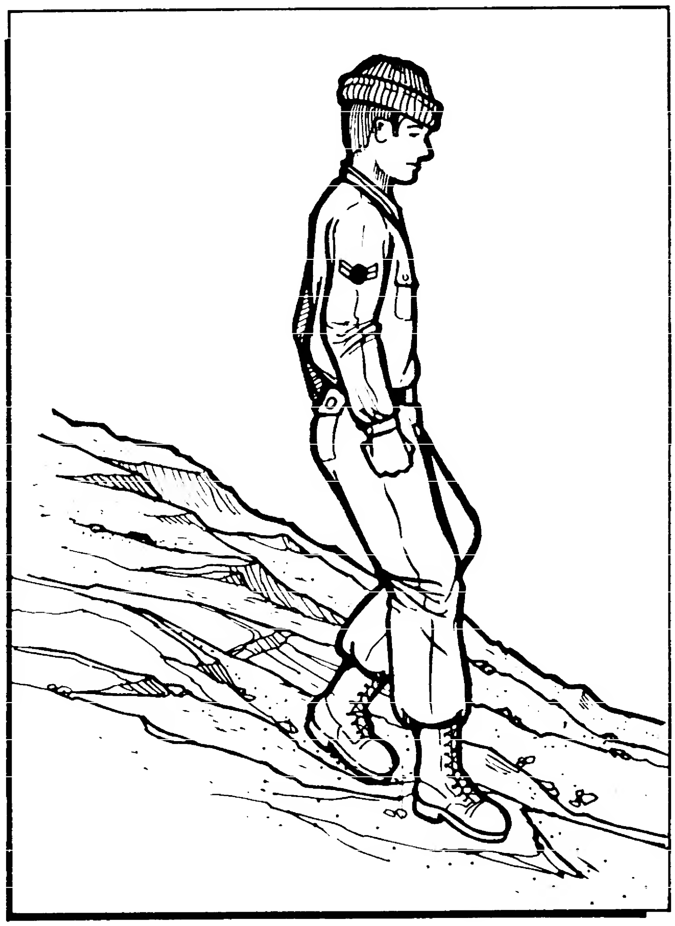


Figure 21-10. Walking Downhill.

Figure 21-11. Walking on Grassy Slopes.

gather their equipment and move out without the assistance of a good pack. The gear may have to be carried in the arms while rapidly leaving the area. In such an instance, it would be better to fashion a roll of the gear and wear it over the shoulder, time permitting. When time is not a factor, it may be desirable to make a semirigid pack such as as square pack. The convenience of being able to keep track of equipment, particularly small items, can be critical in survival situations.

(1) Packsack. A packsack can be fashioned from available survival kit containers or several layers of the fabric from the parachute canopy. The sack is sewed with inner core and a needle.

(2) Square Pack:

(a) The following instructions explain how to improvise a square pack (figure 21-15). Lay a rectangle of

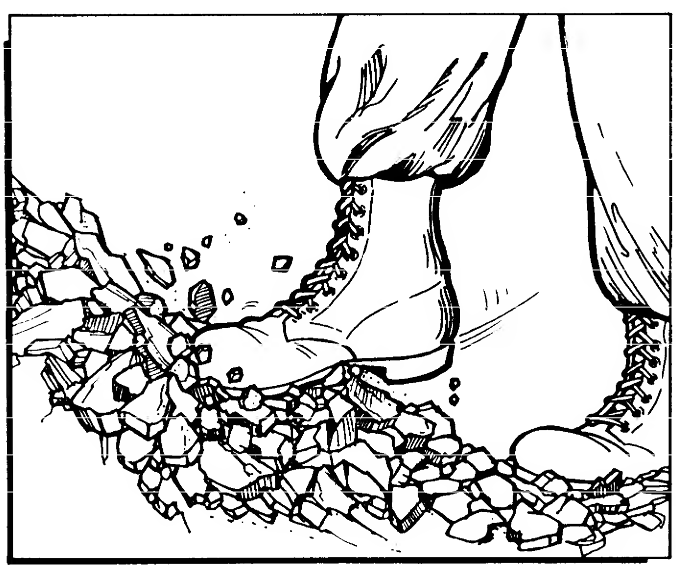


Figure 21-12. Walking on Scree Slopes.

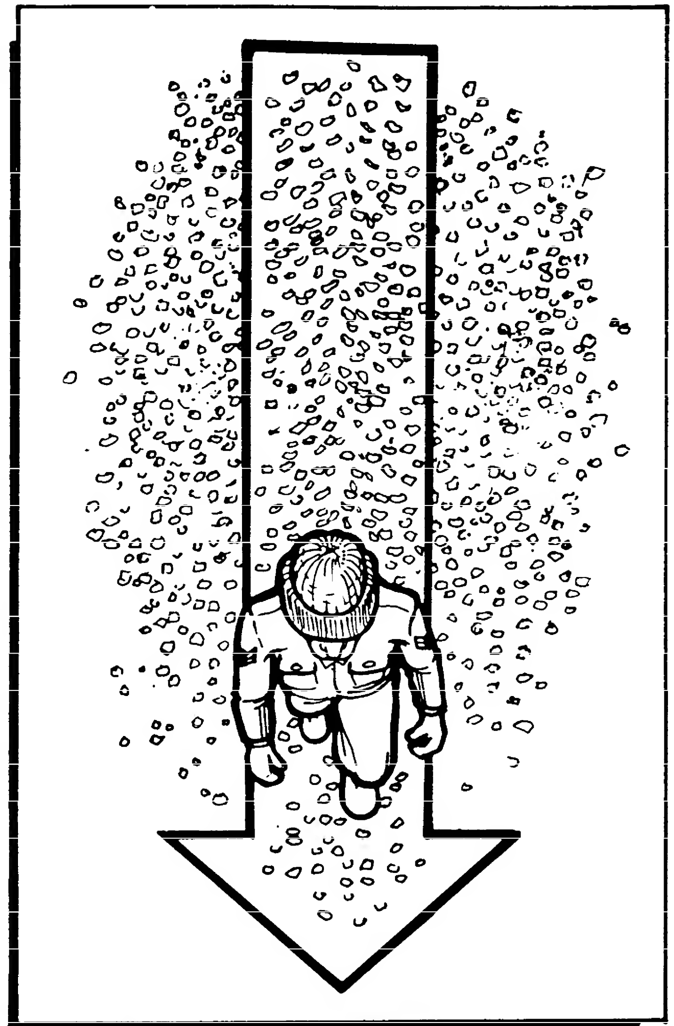


Figure 21-13. Walking Down Scree Slopes.

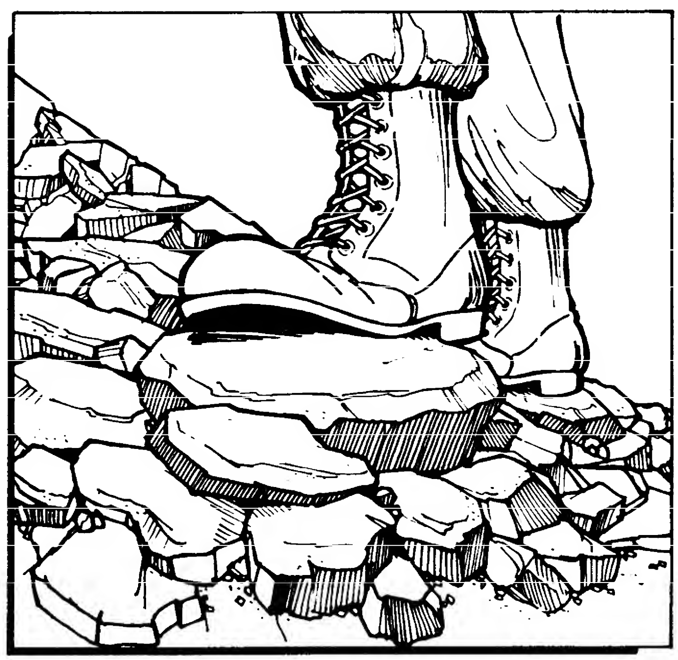


Figure 21-14. Walking on Talus Slopes.

material, waterproof if available, (5 feet by 5 feet minimum size) flat on the ground (examples are plastic, tarp, poncho, paulin 77, etc.) (illustration A). Visualize the material divided into squares like a tic-tac-toe board. The largest piece of soft, bulky equipment (sleeping bag, parachute canopy, etc.) is placed in the center square in an "S" fold. This places the softest item in the pack against the tarp which rests on the back while traveling. If using a poncho, place the sleeping bag just below the hood opening (illustration B). Place hard, heavy objects between the top layer and the middle layer of the "S" fold near the top of the pack. Soft items can be placed between the middle and bottom layer (illustration C).

(b) After all desired items are inside the folds, tie the inner pack in the fashion shown in illustration D. Start with a 1-inch diameter loop in the end of a long piece of parachute suspension line or other suitable line and loop it around the "S" fold laterally. Standing at the bottom of the pack, divide it into thirds and secure the running end of the line to the loop with a trucker's hitch. Both of these hitches should be at the intersection of the thirds so as to divide the pack vertically into thirds. Wrap the running ends around the pack at 90 degrees (working toward the center) to the line and when it crosses another line, use a jam (postal) hitch to secure it and pull both ways to ensure tightness in all directions. When returning to the original Figure 22-42 starting position, use the loop of the tied trucker's hitch to secure another trucker's hitch and the inner part is complete (illustration D). The waterproof materials are then folded around the inner pack as shown in illustrations E and F. Tie the "outer" pack in the same manner ensuring that it is waterproof with all edges folded in securely. If a poncho is used, the head portion may be used to get into the pack if necessary. However, it must be properly secured to ensure that the inner items are protected. With a square pack constructed in this manner, there is no reason why the equipment should get wet. (NOTE: With practice, an excellent pack can be

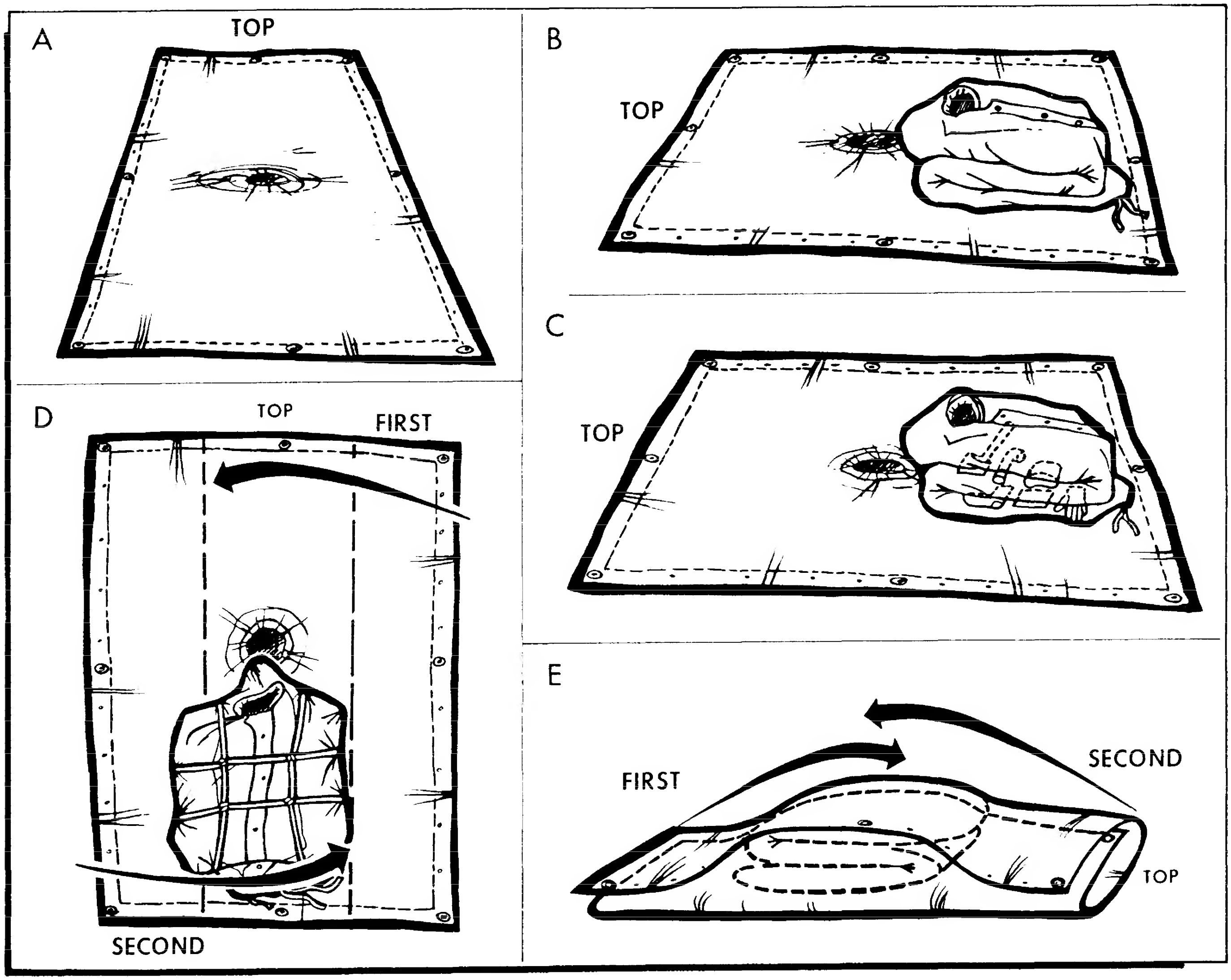


Figure 21-15. Square Pack.

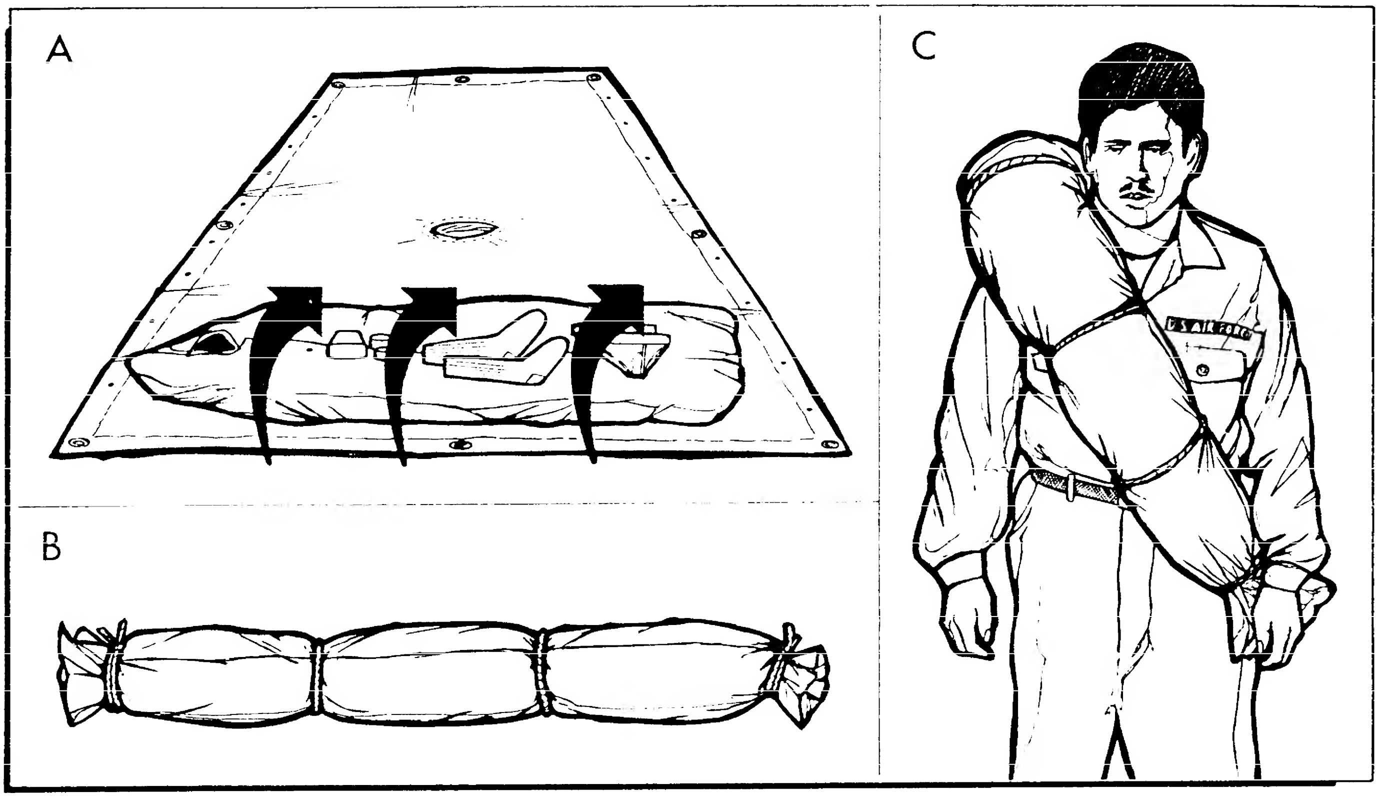


Figure 21-16. Horseshoe Pack.

constructed by tying the inner pack and outer cover simultaneously.)

(3) Horseshoe Pack. The horseshoe pack has been referred to by many names in history including the "Johnny Reb Pack," "cigarette pack," "bed roll," and others. It is simple to make and use and relatively comfortable to carry over one shoulder. It is constructed as follows (figure 21-16): Lay available square-shaped (preferably 5 feet by 5 feet) material (waterproof if available) flat on the ground (illustration A) and place all gear on the long edge of the material, leaving about 6 inches at each end. All hard items should be padded. Roll the material with the gear to the opposite edge of the square (illustration B). Tie each end securely. Place at least two or three evenly spaced ties around the roll. Bring both tied ends together and secure. This pack is compact and comfortable if all hard, heavy items are packed well inside the padding of the soft gear. If one's shoulder is injured, the pack can be carried on the other shoulder. It is easy to put on and remove (illustration C).

b. The most widely used improvised packstrap is called an Alaskan packstrap (figure 21-17). This type of packstrap can be fashioned out of any pliable and strong material. Some suitable materials for constructing the packstrap are animal skins, canvas, and parachute harness webbing. The pack should be worn so it can be released from the strap with a single pull of the cord in the event of an emergency, such as falling into water. The knot securing the pack should be made with an end readily available which can be pulled to drop the pack quickly; for example, a trucker's hitch with safety for normal terrain travel and with the safety removed when in areas of danger, such as water or rough terrain.

(1) Some advantages of the Alaskan packstrap are:

(a) Small in bulk and light in weight.

(b) Easily carried in a pocket while traveling.

(c) Quickly released in an emergency.

(d) Can be adjusted to efficiently pack items of a variety of shapes and sizes.

(e) Can be used with a tumpline to help distribute the weight of the pack over the shoulders, neck, and chest, thereby eliminating sore muscles and chafed areas.

(2) Some disadvantages of the Alaskan packstrap are:

(a) Difficult to put on (without practice).

(b) Experience and ingenuity are necessary to use it with maximum efficiency.

c. The following principles should be considered when packing and carrying a pack:

(1) The pack or burden-carrying device should be adequate for the intended job.

(2) The pack or burden may be adaptable to a pack frame. The pack frame could have a belly band to distribute the weight between the shoulders and hips and prevent undue swaying of the pack. Pack frames are also used to carry other burdens such as meat, brush, and firewood.

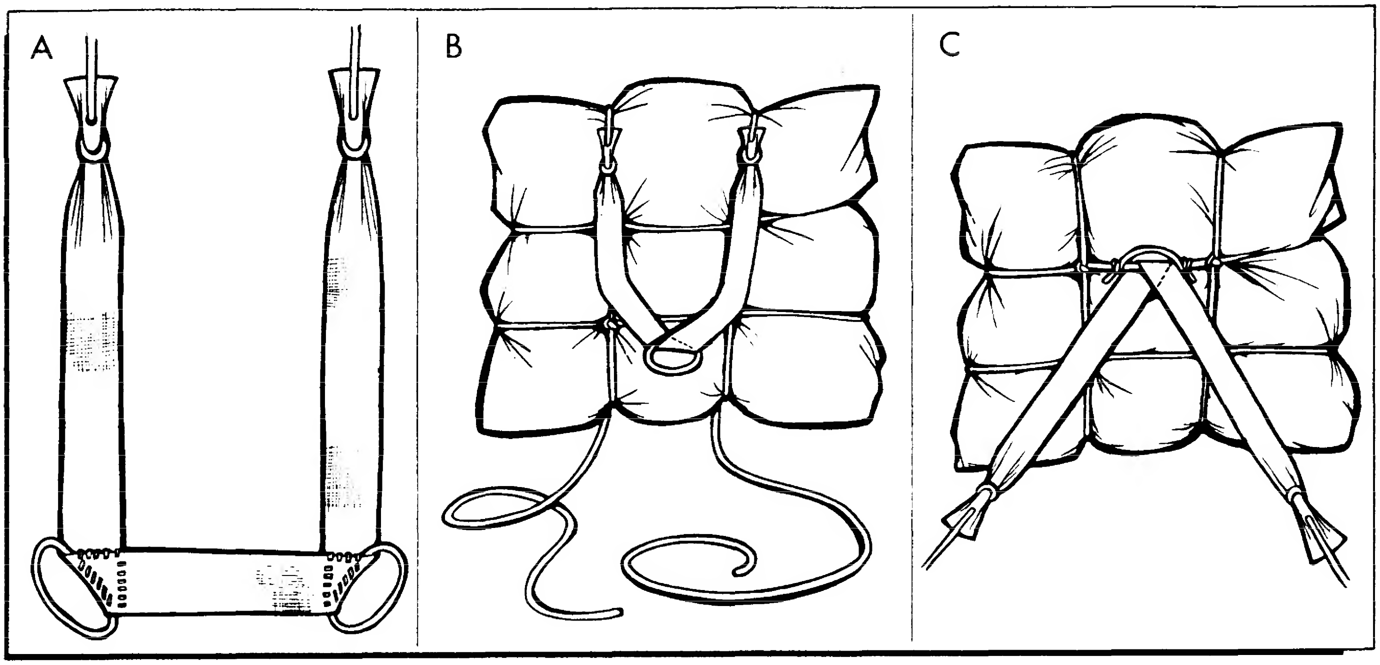


Figure 21-17. Alaskan Packstrap.

(3) Proper weight distribution is achieved by ensuring that the weight is equally apportioned on each side of the pack and as close as possible to the body's center of gravity. This enhances balance and the ability to walk in an upright position. If heavy objects are attached to the outside of the pack, the body will be forced to lean forward. A pack bundle without a frame or packboard should be carried high on the back or shoulders. For travel on level terrain, weight can be carried high. When traveling on rough terrain, weight should be carried low or midway on the back to help maintain balance and footing.

(4) Emergency and other essential items (extra and (or) protective clothing, first-aid kit, radio, flashlight, etc.) should be readily available by being placed in the top of the pack.

(5) Fragile items are protected by padding them with extra clothing or some soft material and placing them in the pack where they won't shift or bounce around. Hard and (or) sharp objects cannot damage the pack or other items if cutting edges are properly sheathed, padded, and not pointed toward the bearer. Items outside the pack should be firmly secured but not protruding where they could snag on branches and rocks.

(6) Adjust and carry the pack so that overloading or straining of muscles or muscle groups is avoided. When using a pack, the straps should be adjusted so they ride comfortably on the trapezius muscles and avoid movement when walking. Back support should be tight and placed to ensure good ventilation and support. During breaks on the trail, rest using the proper position to ease the weight of the pack and take the strain off muscles. (See figure 21-18 for methods of resting.) A comfortable pack is adjustable to the physique of the person. A waistband will support 80 to 90 percent of the weight and is fitted relatively tight. The waistband should be cinched down around the pelvic girdle/crest area to avoid constricting circulation or restricting muscle movement.

d. A tumpline is an excellent aid to burden carrying since it transfers part of the weight of the pack to the skeletal system (figure 21-19).

(1) Tumpline Construction:

(a) Attach a soft band, which rests on the upper forehead, to the pack by using light line. Make the band of any strong, soft material, such as animal skin with hair, tanned skin, an old sock, or parachute cloth. Make the band long enough to reach over the forehead and down to a point opposite each ear. A tumpline does not require any sewing.

(b) Adjust the tumpline to fit the head by making loops at the ends. It is difficult to reach down and behind to make necessary adjustments of the pack, but a person can easily reach up and adjust the pack by using the loops on either side of the forehead.

(c) Make mainstrings from rawhide or parachute suspension lines. Tie them to the lower corners of the pack, bring them up to the loops at the ends of the tumpline, and tie them with a slipknot. Experience is needed to estimate proper adjustments before putting on the pack; however, adjustments can always be made after the packstraps are adjusted.

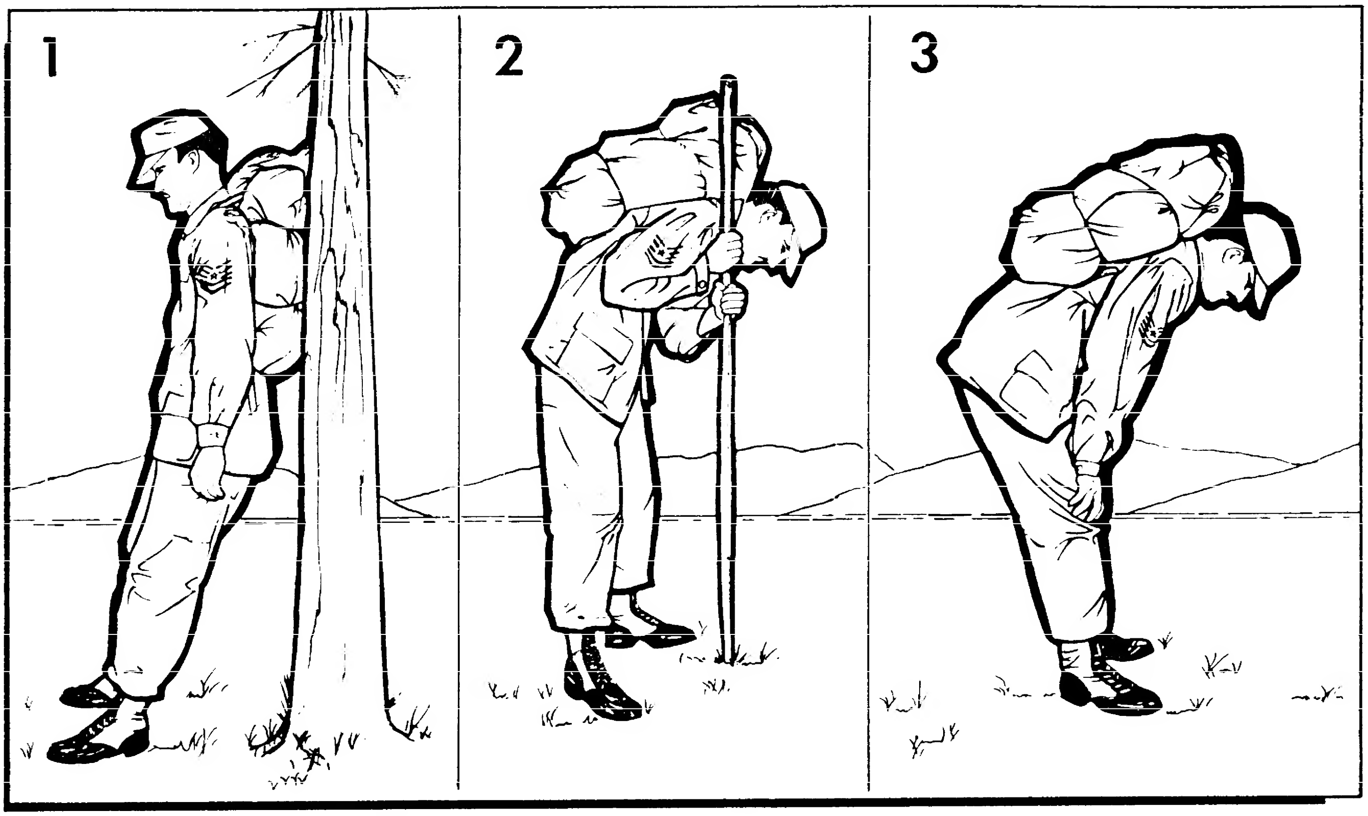


Figure 21-18. Methods of Resting.

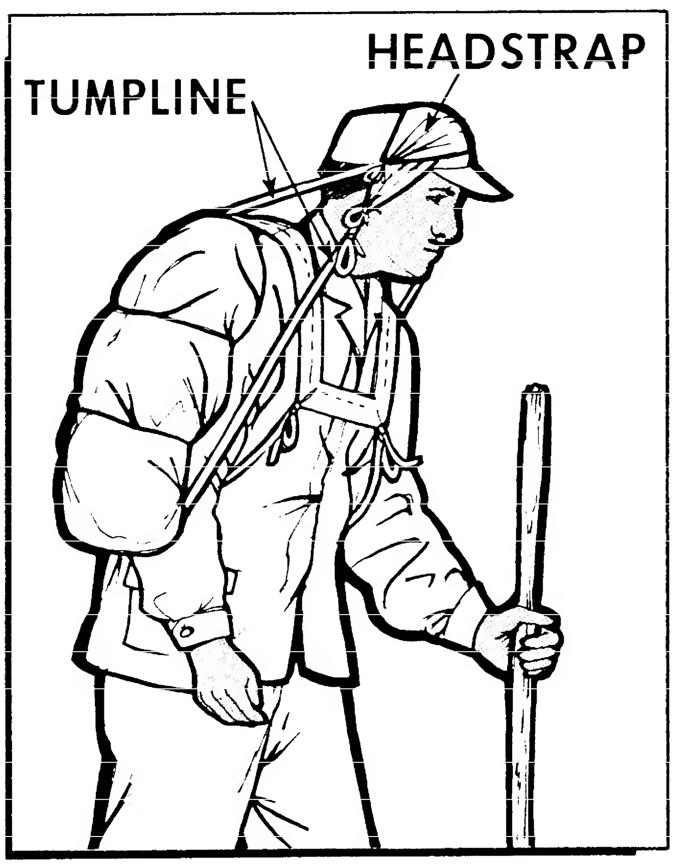


Figure 21-19. Tumpline.

(2) Tumpline Use. The tumpline should be tight enough to transfer about half of the weight of the pack/burden from the shoulders to the head. Occasionally, a heavy pack may cut off the blood circulation to the shoulders and arms. In such cases, a tumpline is of great value. By slight adjustments, most of the weight can be transferred to the head and neck, thereby loosening the shoulder straps and permitting circulation to return to numb arms. A tumpline may cause the neck muscles to be sore for the first few days due to the unusual strain placed on them; however, this discomfort soon disappears. With practice, heavy weights can be supported with only the neck and head. A tumpline can also be used to pack animal carcasses, firewood, or equipment. Since it can be rolled up and carried in a pocket, it can be a real aid to survival.

Chapter 22

ROUGH LAND TRAVEL AND EVACUATION TECHNIQUES

22-1. Introduction. There are survival situations where traveling over rough terrain is required. However, if it is necessary to travel in such areas, specialized skills, knowledge, and equipment are required. These skills may include rope management, specialized knots, belaying and climbing techniques, prusik climbing, rope bridges, rappelling, litter evacuation, etc. The amount and type of equipment needed will depend on the type of operation (climbing, evacuation, etc.).

22-2. Safety Considerations. A safety rope must be used when there is danger of the rescue team or climber falling. The rescue team leader will identify the members of the team who will climb together. Any member of the team may request to be roped during any mountain operation. The rope will be maintained as long as requested by any member. The rescue team leader will decide whether or not the entire team will rope up. Environmental factors may require a rapid retreat. During these circumstances, when speed is critical, it may be desirable to unrope. The rescue team leader's decision to unrope may be overridden by any team member who desires to remain roped. This option pertains to areas such as ridge climbs and low-grade climbs when roping is not required. Solo climbing in severe terrain is not recommended.

22-3. Climbing Ropes. Climbing ropes are made of synthetic fibers, such as nylon. The two essential qualities of a climbing rope are tensile strength and the ability to absorb the shock of a fall. This combination of elongation plus strength varies with the type of rope construction.

a. There are two basic types. The tensile strengths average 5,500 pounds, and the construction designs are called the Kernmantle and the Hauser Lay.

(1) Kernmantle rope consists of a core of braided or twisted strands protected by a braided sheath. They have a 6 to 8 percent stretch factor. Depending upon use, Kernmantle ropes are 9 to 11 millimeter in diameter; standard lengths are 150 feet and 165 feet. Ropes for wet conditions are also available.

(2) Mountain-Lay (three strand hard lay) ropes consist of a right-hand lay of three main strands twisted around each other. These ropes have a 9 to 13 percent stretch (twice as much as Kernmantle ropes) factor. They are constructed in 120-, 150-, and 165-foot lengths and are three-eights to seven-sixteenths inches in diameter.

b. Climbing ropes and anchor slings require special care. Stepping on the ropes will grind abrasive dirt particles into them which will cut the fibers of the rope. Contact between the rope and sharp corners or edges of rocks should be avoided. This may cut the rope. If the rope must run over a sharp edge, it should be padded (figure 22-1). The ropes should be kept dry because wet ropes are not as strong and collect more dirt. Do not hang ropes on sharp edges. Do not let one rope rub against another during use. Nylon rubbing on nylon will create friction which can burn through the rope(s). This is called weld abrasion. Smoking around ropes should be prohibited and they should not contact any source of excessive heat. Petroleum products will accelerate deterioration of nylon. When not in use, protect the rope from the ultraviolet rays of the Sun which also have a deteriorating effect on nylon.

c. Before constructing any rope system, the ropes should be backcoiled or layed out. This is done by simply removing the rope from the coil and, starting with one end, arranging the rope into neat overlapping loops on the ground. This inspection ensures the rope is free of knots or kinks (figure 22-1).

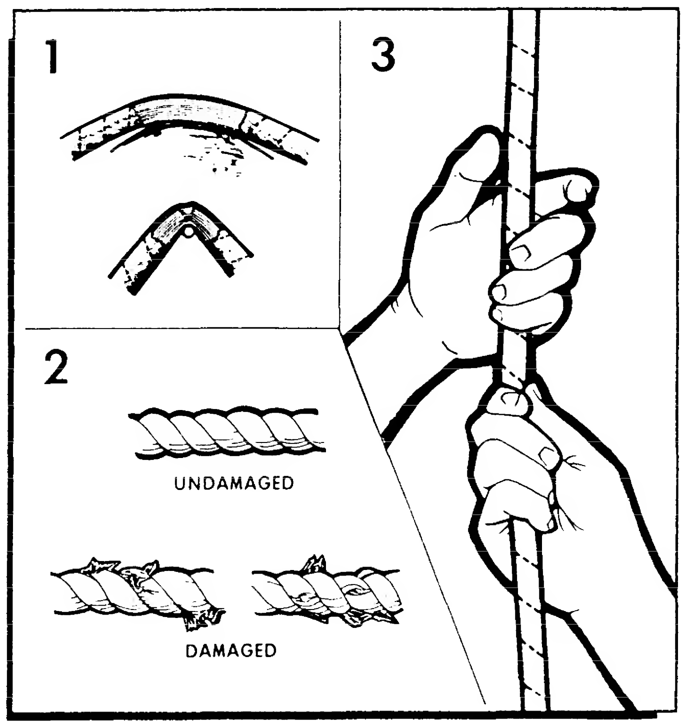


Figure 22-1. Damaged Rope.

(1) Before throwing the rope, one end should be secured. This end should be the standing end on the backcoil. Next, several small loops are taken from the working end and placed in one hand, several more loops are placed in the other hand. The throw is done by raising the hand closest to the rope end (running end)

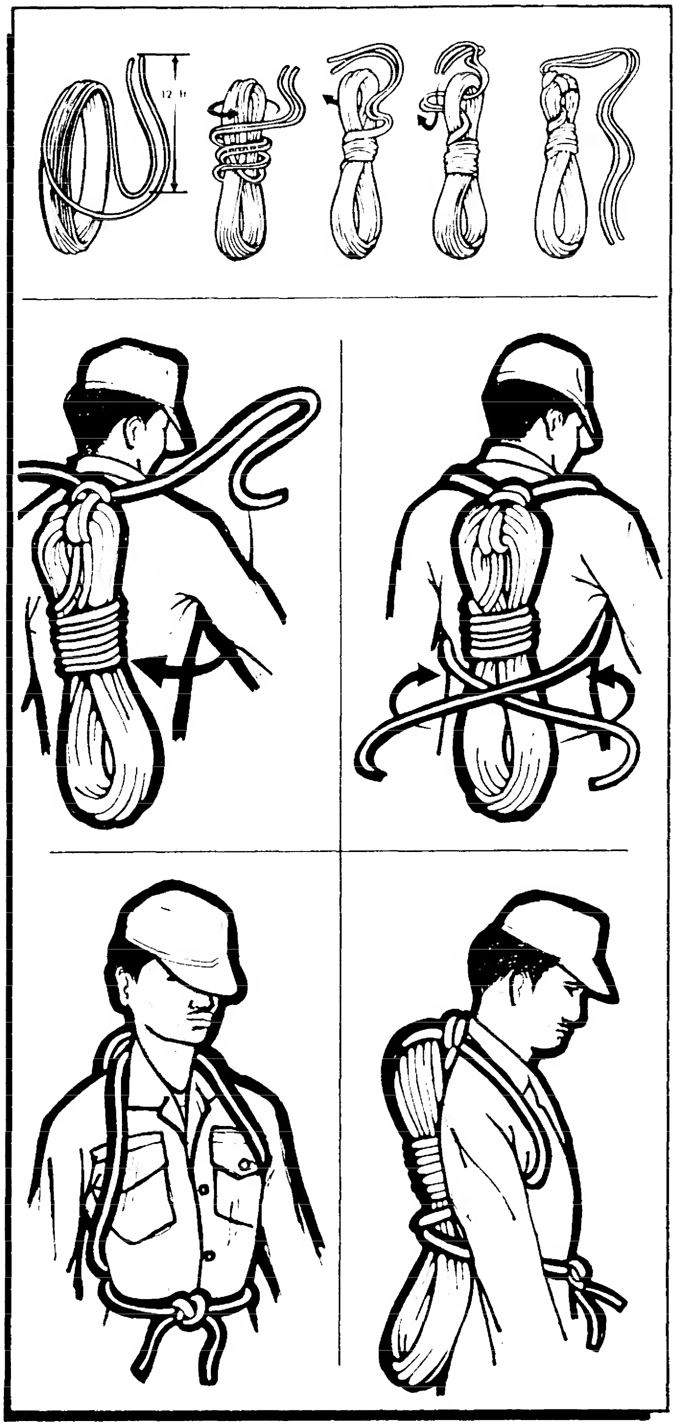


Figure 22-2. The European Coil.

over the head and throwing the loops out and down in the intended direction. The loops in the other hand are allowed to drop immediately after the running end is thrown. Properly done, the remaining rope will feed out. Before throwing the rope, the term "rope" should be sounded. This will alert anyone below to the danger of falling rope. Wait for the response "clear" if there is someone below. Under normal conditions, there should be no knots in the rope or any equipment attached to the rope due to the possibility of the rope becoming entangled if it should snag on a rock, brush, etc.

(2) Two common methods are used to coil rope:

(a) The European coil is done by starting in the center of the rope, coiling the rope into 3-foot diameter loops until there is about 12 feet of rope tail left on the two ends. The ends are then wrapped three to four times around the coil, a bight is passed through the center of the coil, and the tails passed through the bight. This is then tightened down with two remaining tails of about 6 feet. The coil can now be carried by placing the coil on the back, passing one end over each shoulder, between the arm and the chest, and passing around the back to return to the front of the body. The two ends are now secured at waist level (figure 22-2).

(b) To form a mountain coil, one end of the rope is taken in one hand while the other hand is run along the rope until both hands are outstretched. The hands are then brought together forming a loop which is transferred to one hand. This is repeated, forming uniform coils, until the entire rope is coiled. To secure the coil, a 12-inch bight is made in the standing end of the rope and laid on top of the coil. Drop the last loop on the coil and take this length of rope and wrap it around the coil and the bight. The first wrap is made at the open end of the bight to lock. Continue to wrap toward the closed end of the bight until just enough rope remains to be run through the inside of the bight. Pull the running end of the bight to secure the coil (figure 22-3). The coil may now be carried draped over a pack or over one shoulder and beneath the other.

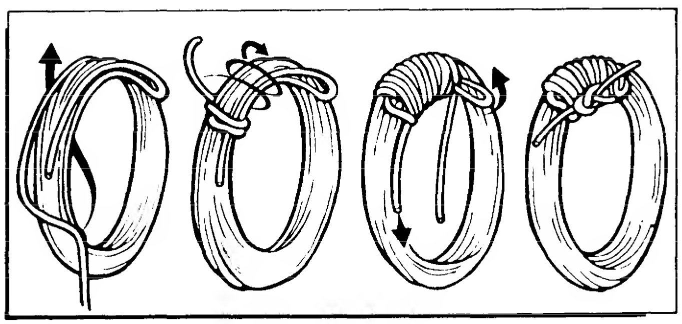


Figure 22-3. The Mountain Coil.

22-4. Specialized Knots for Climbing and Evacuation. Each of the following knots have a specific purpose. These knots have survived the test of time and are used in maintaining operations. They are designed to have the least effect on the fiber of a rope lock without slipping, and they are easy to untie when wet and icy. All knots reduce the strength of ropes; however, these knots reduce the strength of the rope as little as possible. Most

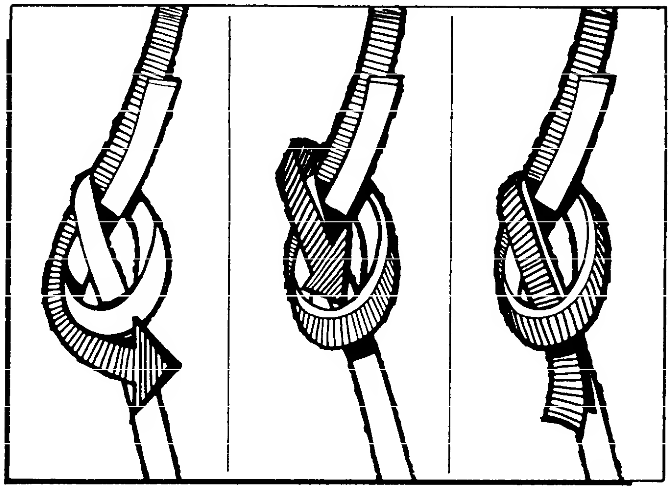


Figure 22-4. The Water Knot.

knots should be safetied with an overhand knot or two half hitches. A knot does not have to be safetied if the knot is designed for the middle of a line or if it is 15 feet or more from the end of the rope.

a. The water knot or right bend is used for joining nylon webbing (figure 22-4).

b. The double fisherman's bend is used to securely join Kernmantle or hard lay lines (figure 22-5).

c. The double figure-eight knot is used for temporarily joining Kernmantle or hard lay ropes (rappels, Tyrolean traverses) (figure 22-6A). Carabiners should be placed between lines within the knot to prevent the knot from clinching down when loaded. The figure-eight loop may be tied at the end or in the middle of a line establishing a fixed loop (figure 22-6B). If the loop is tied at the end of the line, then an overhand or single fisherman's safety knot must be used. The figure eight on a bight is used to provide two loops from a single knot to attach to two different anchors (figure 22-7).

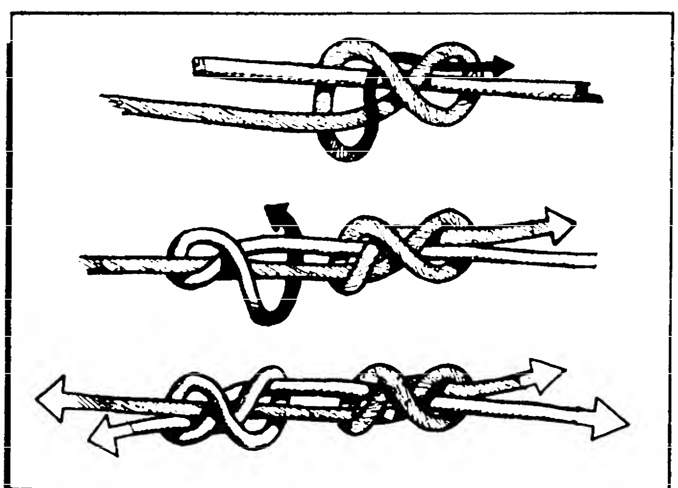


Figure 22-5. Double Fisherman's Bend.

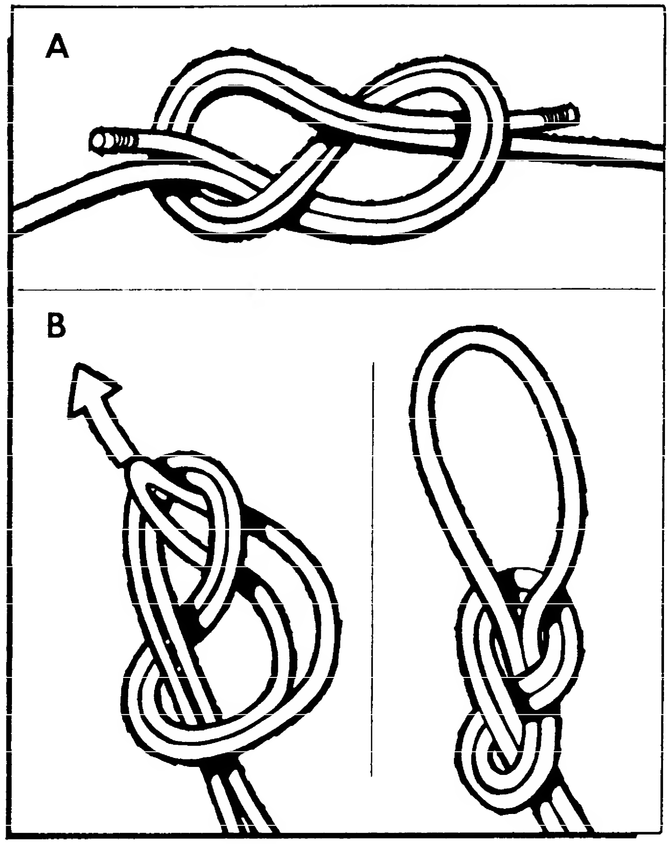


Figure 22-6. Figure-Eight Loop.

d. The butterfly is used to make a fixed loop in the middle of a line where the direction is between 120- to 180-degree angles (figure 22-8). For angles less than 120 degrees, a figure eight in a loop will suffice. For an angle of pull greater than 120 degrees, the figure eight will become weakened and begin to split.

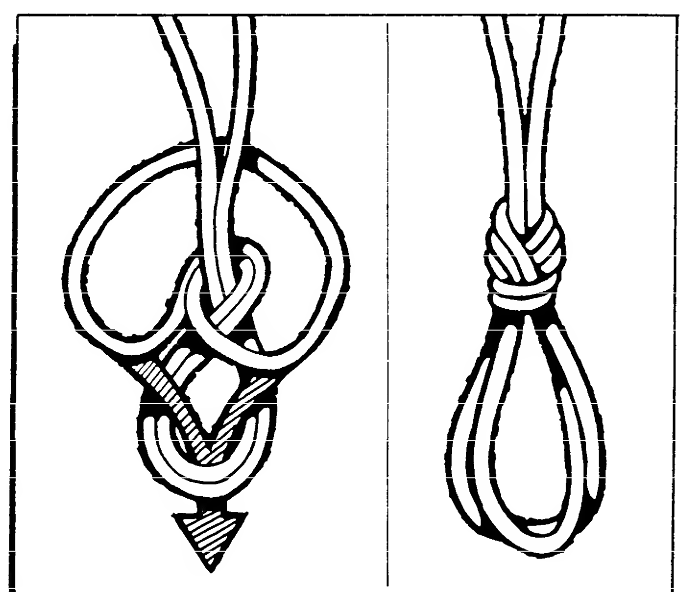


Figure 22-7. Figure-Eight with Two Loops.

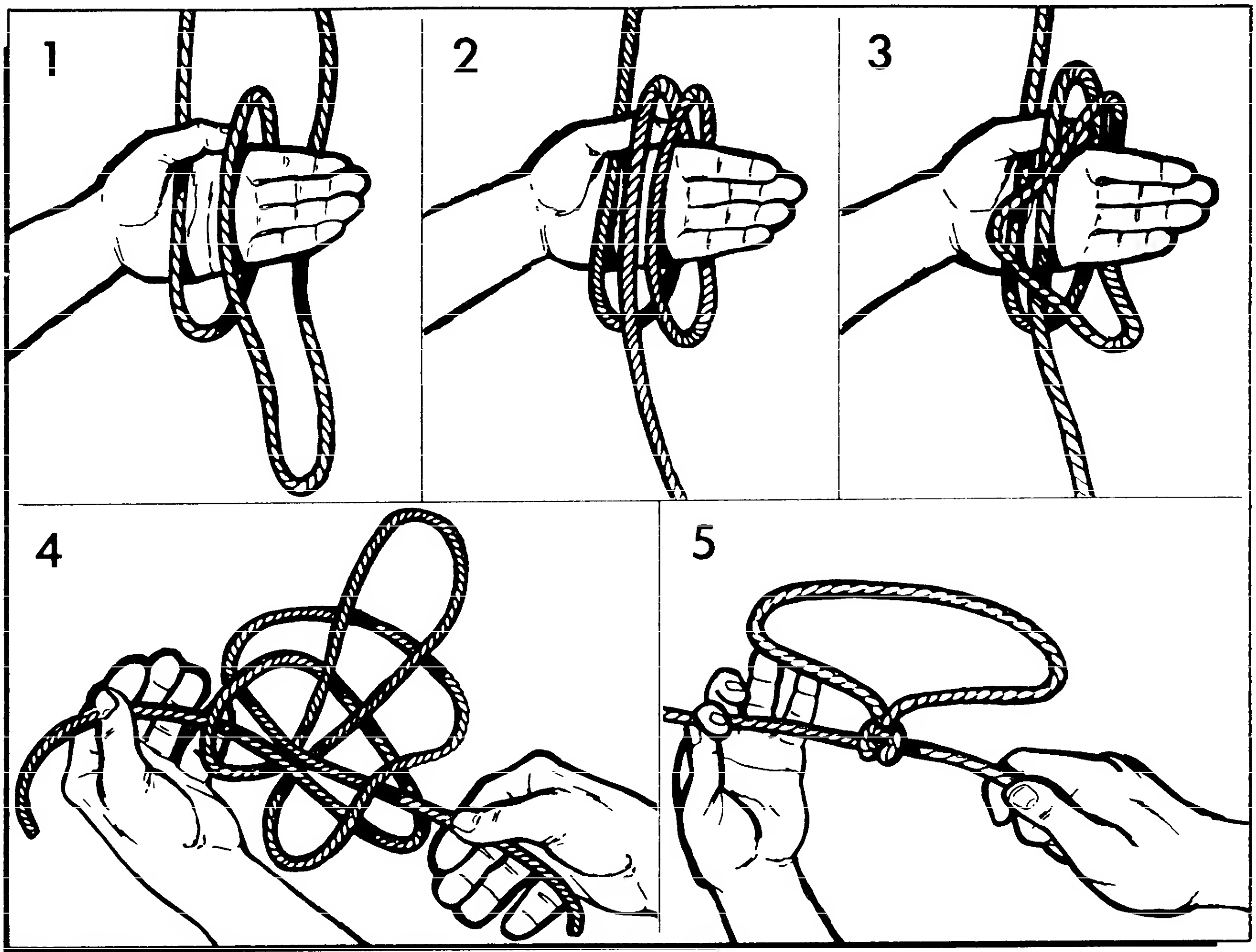


Figure 22-8. Butterfly Knot.

e. The prusik knot may be used to ascend a fixed line or safety a rappel (figure 22-9).

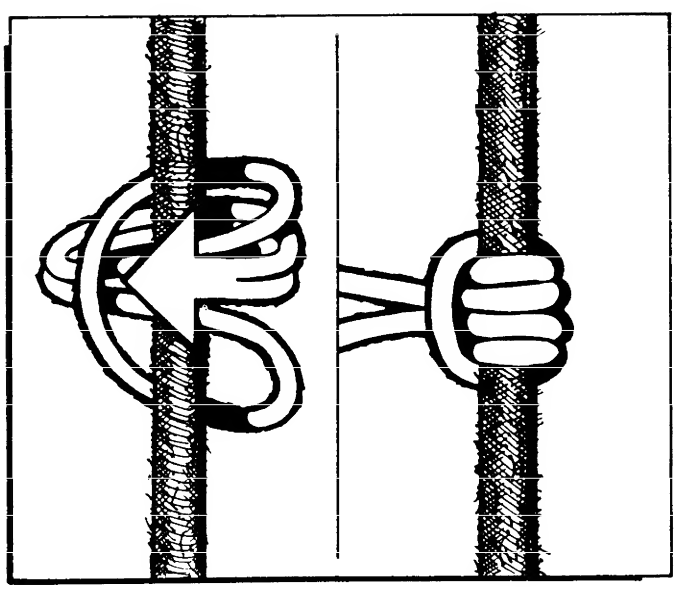


Figure 22-9. Prusik Knot.

f. A three-loop bowline is a variation of the bowline on a bight. It is used for three anchor points or as an improvised harness (figure 22-10).

g. The mariner's knot is a combination of two knots tied with a sling and a carabiner (figure 22-11) and used

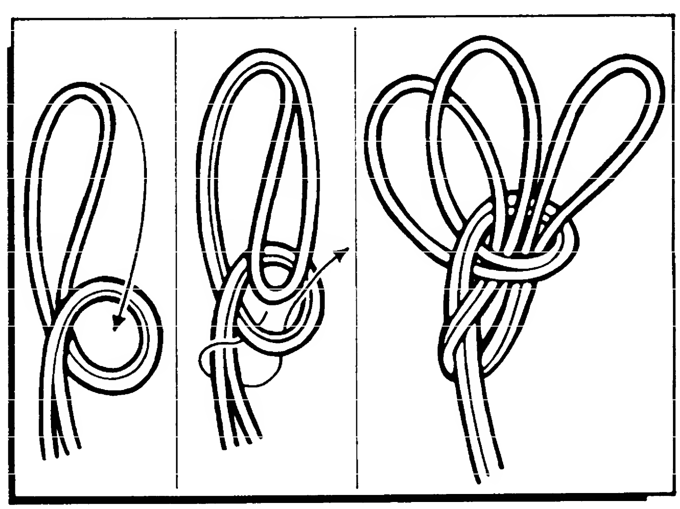


Figure 22-10. Three-Loop Bowline.

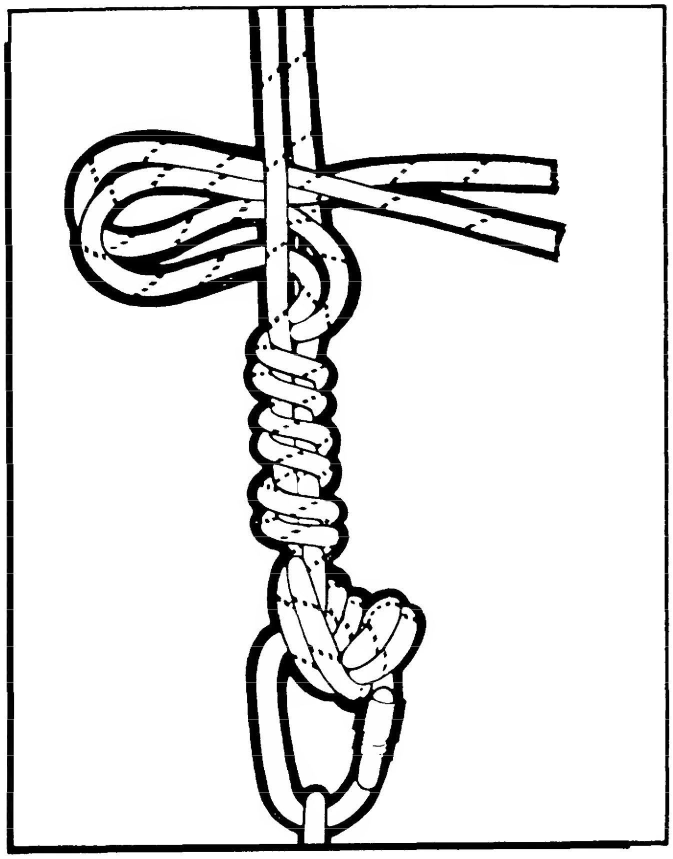


Figure 22-11. Mariner's Knot.

to transfer loads from one system to another. With a sling, a prusik is placed on the main rope (load rope). The remaining portion of the sling is then wrapped three times through the anchor carabiner and then three times around itself next to the carabiner. The remaining tail is tucked between the two sides of the sling. Tension may be gradually released by removing the wraps.

22-5. Special Equipment. Without proper equipment, safety is jeopardized and travel is impossible in severe terrain.

a. Seat Harness. The seat harness is a safety sling which is used to attach the rope to the climber or rappeller. It must be tied correctly for safety and comfort reasons. An improvised seat harness can be made of 1-inch tubular nylon tape. The tape is placed across the back so the midpoint (center) is on the hip opposite the hand that will be used for braking during belaying or rappelling. Keep the midpoint on the appropriate hip, cross the ends of the tape in front of the body, and tie half of a surgeon's knot (three or four overhand wraps) where the tapes cross (figure 22-12). The ends of the tape are brought between the legs (front to rear), around the legs, and then secured with a jam hitch to tape around the waist on both sides. The tapes are tightened by pulling down on the running ends of the tape. This must be done to prevent the tape from crossing between the legs (figure 22-12). Bring both ends around to the front and across the tape again. Then bring the tape to the opposite side of the intended brake hand and tie a square knot with an overhand knot or two half-hitch safety knots on either side of the square knot. The safety knots should be passed around as much of the tape as possible (figure 22-12). Once the seat harness has been properly tied, attach a single locking carabiner to the harness by clipping all of the web around the waist and the web of the half surgeon knot together. The gate of the carabiner should open on top and away from the climber.

b. Commercial Seat Harness. A commercial seat harness is a climbing harness which is worn around the pelvic girdle and is used with climbing ropes for descending and ascending devices and for rescue evacuations. The harness is easily donned, comfortable, allows freedom of movement, and evenly distributes the body

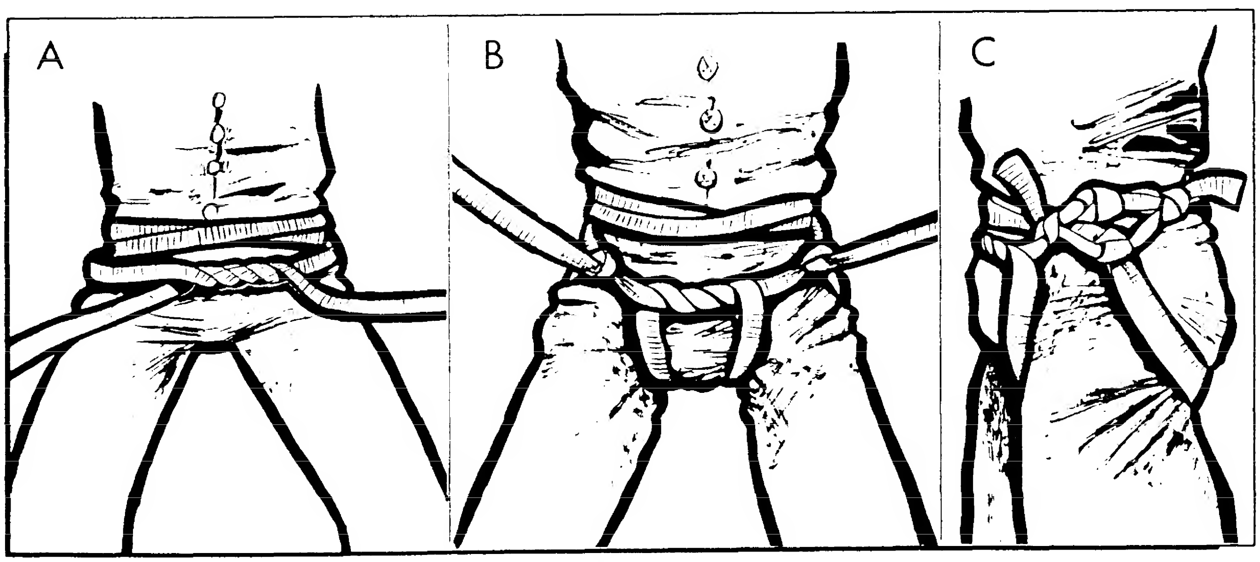


Figure 22-12. Improvised Seat Harness.

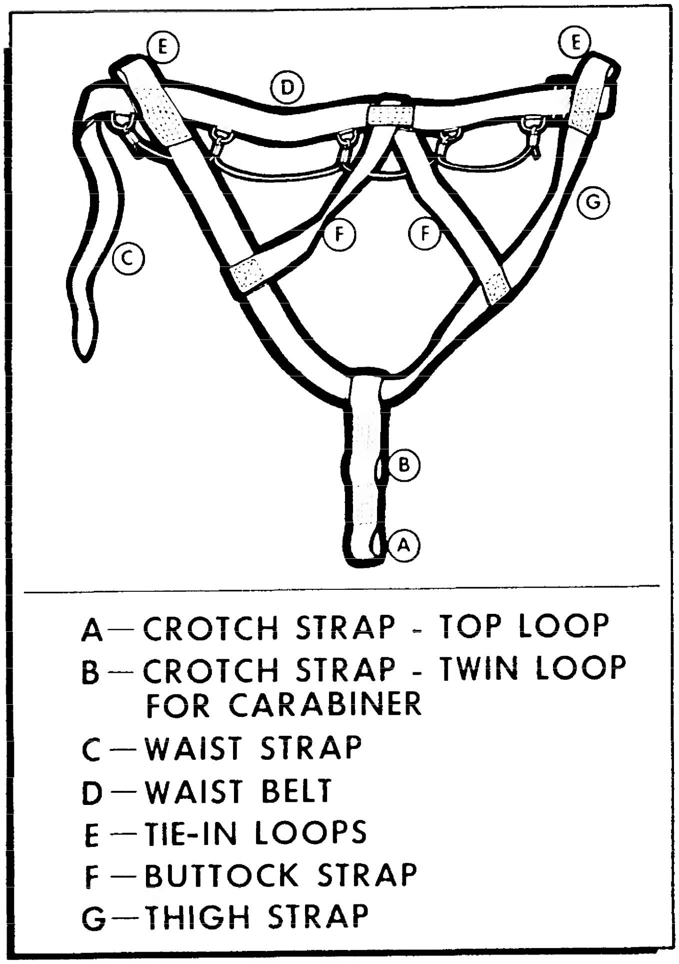


Figure 22-13. Sit Harness.

weight to the pelvic region. Figure 22-13 identifies the parts of the harness. The seat harness webbing should be cared for in the same manner as all webbing. The plastic buckle should not be subject to direct jars since it may fracture or establish a weak point on the buckle which can fail when used. It is primarily constructed of nylon webbing with box stitching at juncture points. Small metal rings are sewn on the lower half of the waist belt and connected with 300-pound line for equipment storage. The harness should have tie-in loops. Webbing should not have tears, rips, burns, or have been subjected to chemical exposure. The plastic buckle should not have fracture marks. All seams and thread should be intact. Harnesses showing signs of excessive wear, tear, rips, burns, or exposure to chemicals should be removed from service. Fractured buckles should be replaced.

c. Improvised Chest Harness. The Parisian bandolier or chest harness is a secondary safety sling used to attach to a safety sling at the top of climbs or for top belaying on high-angle rappels. A Parisian bandolier is made from a continuous loop of webbing. The loop should be 3 to 4 feet long. The knot connecting the two ends of tape together is a water knot with an overhand knot or half hitch as safeties. To don the bandolier, place one arm through the loop and bring the running end of the loop behind the back and under the opposite arm. A sheet bend is tied in the center of the chest by using the center of the tape which was passed under the climber's arm and inserted through the portion of bight formed by the tape that goes over the shoulder (figure 22-14).

d. Climbing Helmet. Climbers should wear this hard shell helmet which is designed to minimize injury dur-

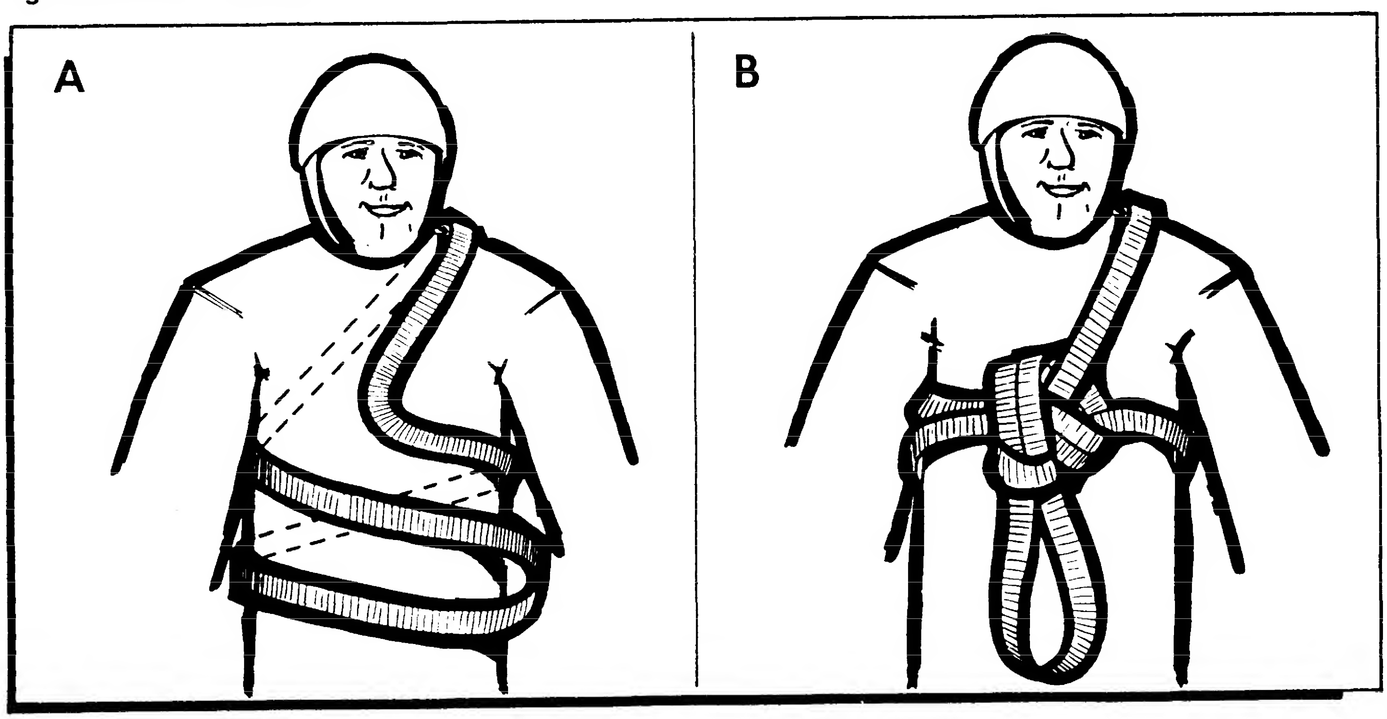


Figure 22-14. Parisian Bandolier.

Figure 22-15. Climbing Helmet.

ing falls or when struck by a small object falling from above their position. The helmet consists of a hard shell which is held away from the head by a suspension system. The suspension system absorbs a portion of the blow to the top of the helmet. Helmet fit should be such that the side of the head is protected. A "Y" style strap system of lightweight webbing retains the helmet on the head better than a single strap. The headband is adjustable to allow donning over a watch cap in cold weather (figure 22-15). The hard shell should not have cracks or breaks. The suspension system must be securely riveted in place. The straps must be free of cuts, frays, and securely fastened to the helmet.

e. Gloves. Gloves should be worn when belaying or rappelling. Since these techniques are performed frequently, the gloves should be attached to the climber (rescuer) at all times.

f. Slings. Slings have many uses in adverse terrain work—construction of anchor systems, stirrups to aid movement, attachment to chocks, improvised harness-

SIZE	MOUNTAIN-LAY	KERNMANTLE	NYLON WEB
5/16" OR 7 MM WIDE	2700	2300	
3/8" OR 9 MM WIDE	3700	3200	
7/16" OR 11 MM	5500	4800	
1/2" WIDE			1100
9/16" WIDE			1700
1" WIDE			4000

Figure 22-16. Breaking Strength of Rope.

CARABINER BREAKING STRENGTH		
TYPE	MINIMUM	MAXIMUM
STANDARD OVAL, ALLOY	3890	4210
STANDARD D, ALLOY	4065	5515
LOCKING D, ALLOY	4960	6310
LOCKING D, STEEL	GREATER THAN 11,000 POUNDS	

Figure 22-17. Breaking Strength of Carabiners.

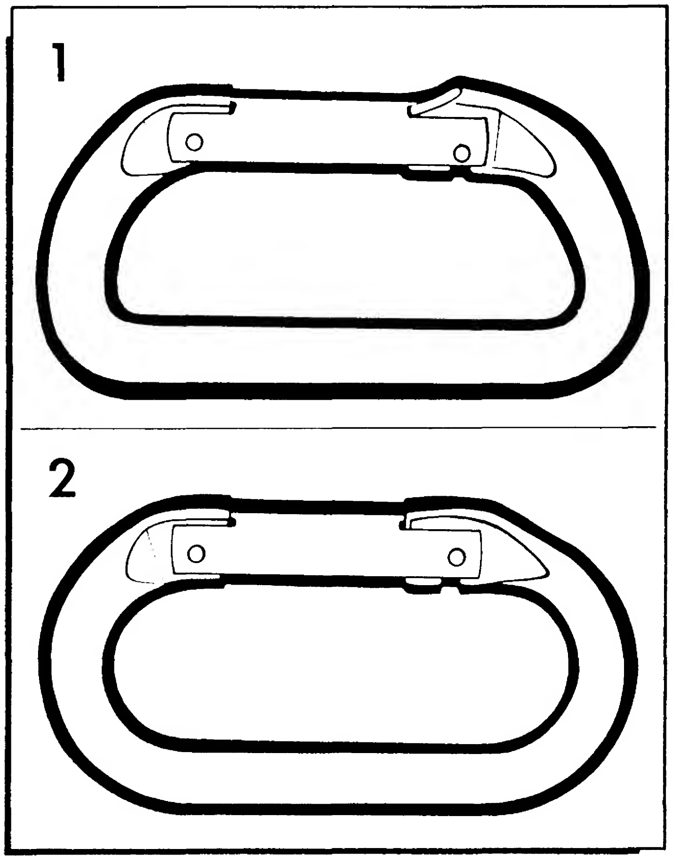


Figure 22-18. Types of Carabiners.

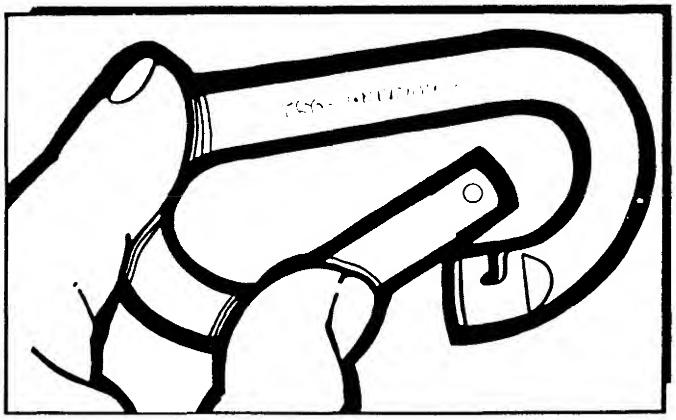


Figure 22-19. Nonlocking Carabiners.

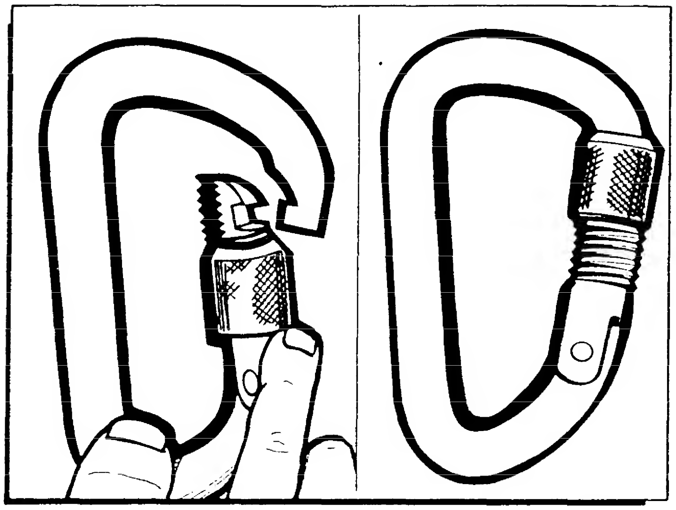


Figure 22-20. Large Locking Carabiner.

es, and to attach equipment to rope systems. Slings may be constructed from Mountain-Lay, Kernmantle, and flat or tubular nylon. The standard length for long slings is 13 feet with smaller slings cut to the individual task. For climbing, slings about 4 feet long, giving a circumference of 2 feet, are acceptable. Sling rope diameters for Mountain-Lay or Kernmantle are 5 mm, 7 mm, and 9 mm while tape slings are usually one-half inch or 1 inch wide. During construction of any system or slinging of chocks, the largest possible rope diameter or tape width should be used. Mountain-Lay and Kernmantle ropes used for slings are the same as climbing ropes. Nylon webbing is constructed of multiple strands of nylon sewn in a weave pattern throughout the length. It should be constructed in flat or tubular shapes. Specific strengths are noted in figure 22-16. Nylon webbing which is burned, torn, cut, or frayed should be removed from service. If nylon webbing is suspected to be inferior due to shock, loading, or abuse, it should not be used.

g. Carabiners. The carabiners used by climbers (rescuers) fall into two material designs—aluminum alloy and chrome vanadium steel. Both material designs may be either locking or nonlocking. Alloy metals provide the maximum strength for adverse terrain work. As with ropes, carabiners are rated differently depending on the manufacturer. Figure 22-17 depicts the breaking strengths for the various types of carabiners. Aluminum alloy and chrome vanadium steel carabiners will be oval-shaped or D-shaped (figure 22-18).

(1) Alloy standard oval (nonlocking) is shaped in an oval with a gate to allow access into the center of the oval. The gate contains a locking pin which fits into the locking notch when the gate is closed (figure 22-19). The alloy D-shape (nonlocking) is shaped in the fashion of a D which allows greater distribution of weight applied to the longer side. Features and operation are the same as the standard oval.

(2) Alloy locking D or oval are both constructed the same as previously discussed but are machined with threads on the gate and a sleeve which, when screwed clockwise, will cover the locking notch and pin for a positive lock. The steel locking D is the same construction as the alloy locking D, but is made of steel and is normally used for mountain rescue work (figure 22-20).

(3) Carabiners should not be dropped or used for other than the designed purpose since small fracture lines may develop and weaken the structure. Carabiners should not be used as a hammer nor loaded (stressed)

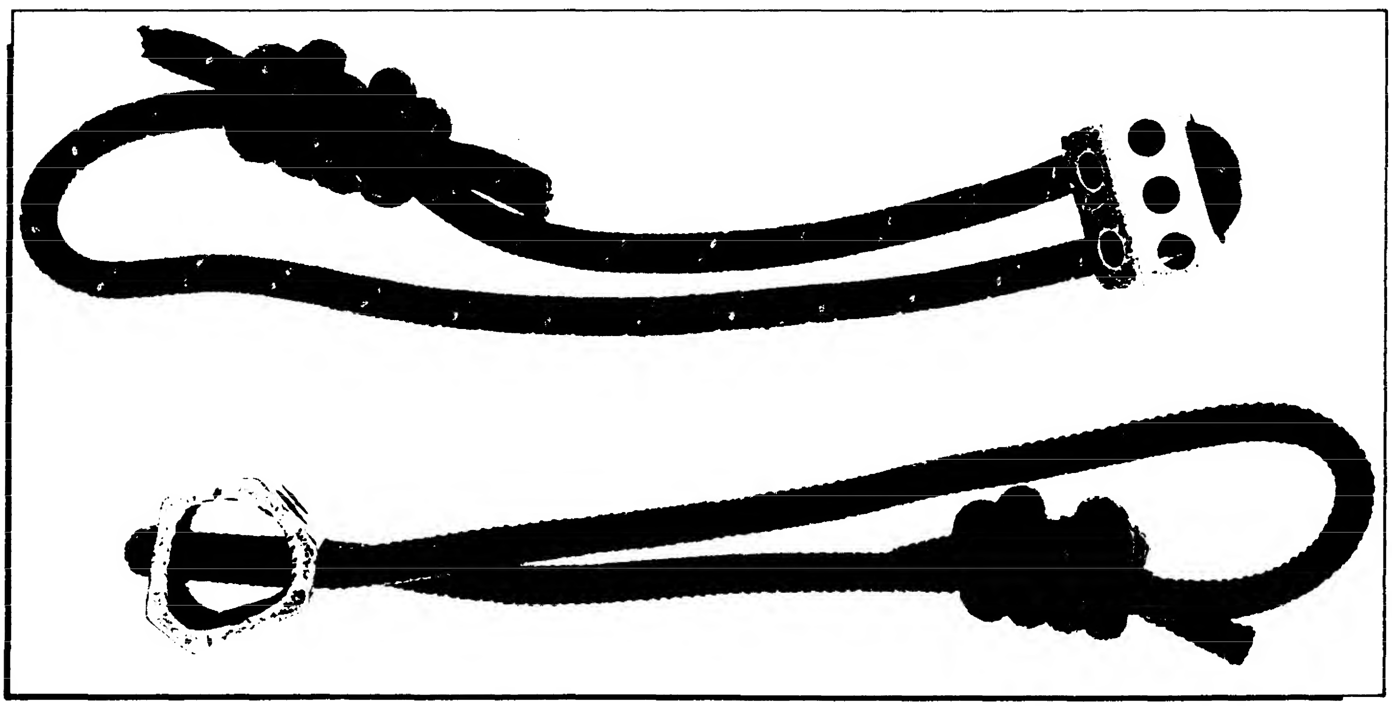


Figure 22-21. Hexcentric Chock with Kermantle Sling.

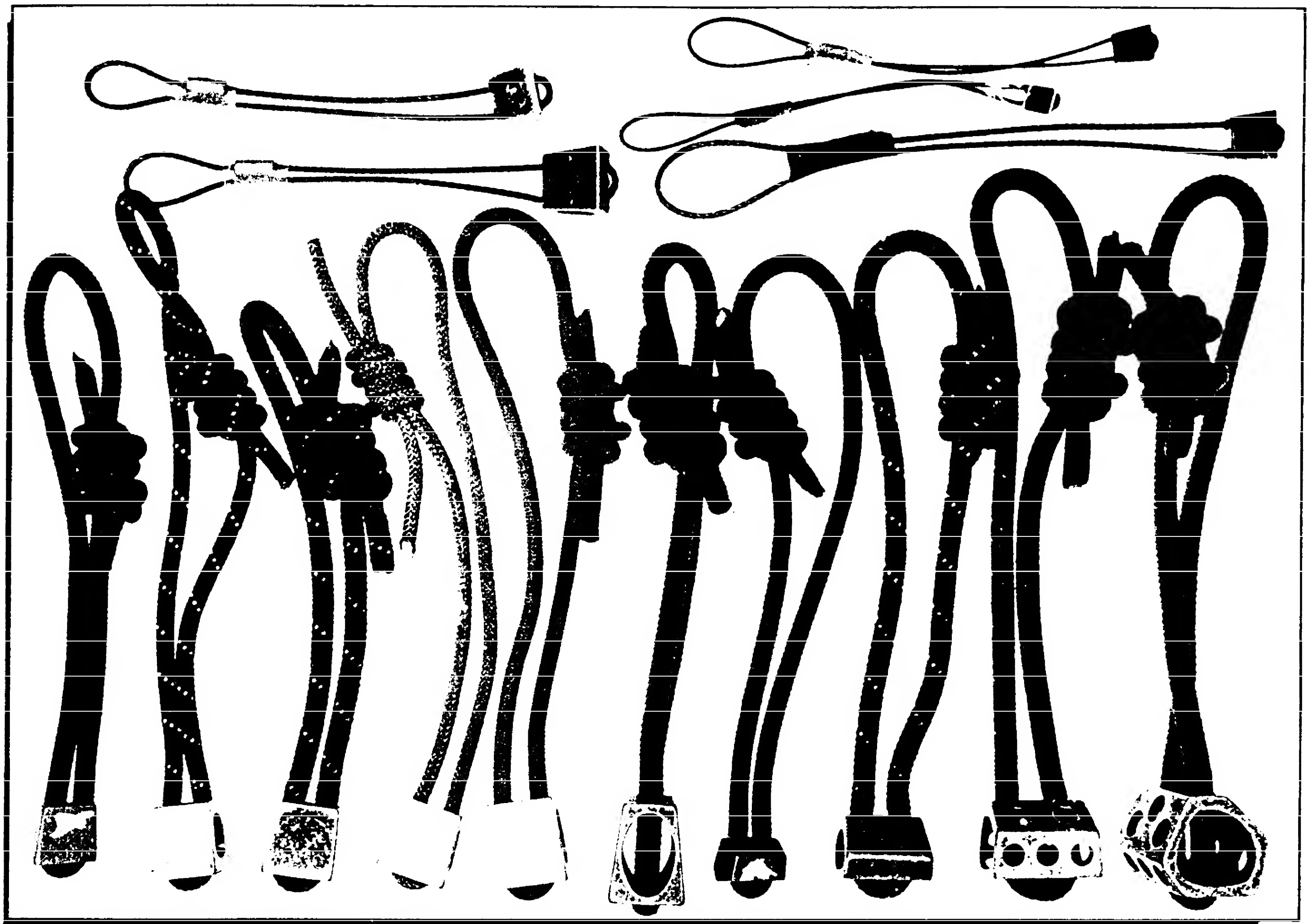


Figure 22-22. Chocks.

beyond their maximum breaking strength. The moving parts, hinge and sleeve, of locking carabiners should be kept clean for free movement. If a carabiner "binds," do not oil it — discard it! Carabiners should not be filed, stamped, or marked with an engraving tool. Colored tape or Teflon paint may be used to identify carabiners. All moving parts (gate, locking sleeve) should operate freely and the locking pin must properly align with the locking notch. Obvious fractures, regardless of size, are cause for condemning a carabiner.

h. Chocks:

(1) Chocks are metal alloy or copper shapes with unequal sides which are placed within cracks in rocks to serve as anchor points or parts of a protection system. Figures 22-21 and 22-22 show the common chocks used. Each is designed to fit within a variety of cracks in rocks. Sizes vary from one-sixteeth inch thick by one-fourth inch wide to several inches thick and wide. The various shapes with uneven sides allow one size to fit many rock openings. Carrying different sizes of chocks allows a person to choose the most suitable chock for the job. Depending on the style, chocks are constructed differently and require a sling for use.

(a) Copperhead. A cylindrical copper chock ranging from three-sixteeths inch in diameter by one-half inch long to one-half inch in diameter by 1 inch long. The relatively soft head bites well into rock and has

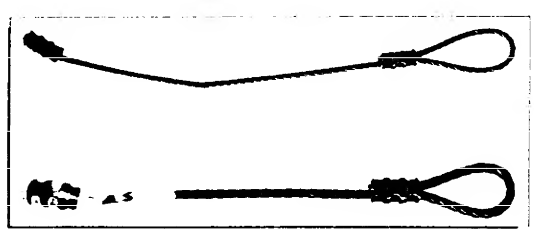


Figure 22-23. Copperheads.

little rotation after placement. It is manufactured with a cable sling attached (figure 22-23).

(b) Hexentric. A metal alloy chock constructed with six sides. Each side is a different length than the opposing side (figure 22-21). The two ends are tapered, gradually getting smaller from the back to the front of the chock. The front of the hexentric chock is the narrowest of the faces. Small hexentric chocks are manufactured with wire slings and larger ones have two holes bored through the front to back for threading of a Kernmantle sling. Kernmantle slings vary with the size of the chock, from 5 mm to 9 mm. The largest sling size possible will be used with each chock.

(c) Wedge. A solid alloy metal chock shaped in the form of a wedge. All four sides decrease in size from back to front. As with small hexentrics, small wedges are manufactured with wire slings while larger wedges require Kernmantle slings.

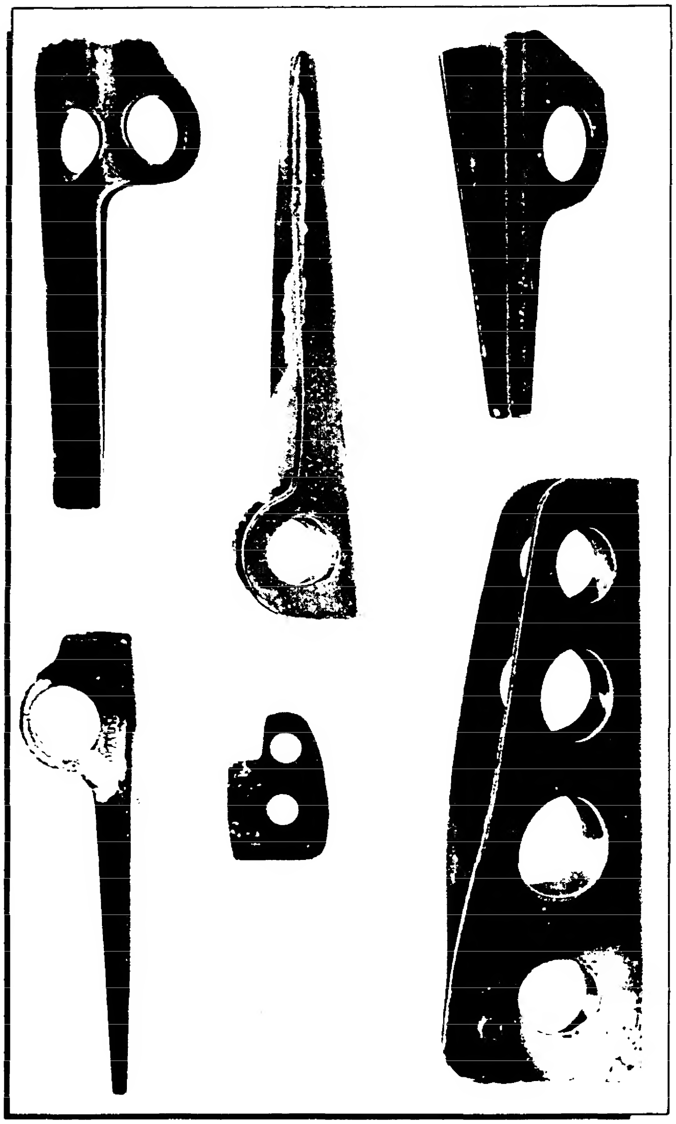


Figure 22-24. Pitons.

(2) All chocks should be treated the same as carabiners. However, chocks will take considerable abuse since they are wedged in rock, and at times, the leverage of a hammer may be required to remove them. Chocks manufactured with wire slings and wedges should be closely monitored for security. If there is doubt about the condition of a wedge, it must not be used. Rope or tape slings on chocks must meet inspection requirements. Cracks in any surface of the chock is cause to remove it from service. Small scratches or grooves on the outer surfaces are not cause for removal from service.

i. Pitons. Pitons are metal alloy spikes of various shapes, widths, and lengths which are hammered into cracks in rock surfaces for anchor points or as part of a protection system. The different shapes are identified by name; each name has the same shape but comes in various sizes in length and width. Figure 22-24 depicts the types of pitons. Pitons are divided into two different categories—blades, whose holding power results from being wedged into cracks; and angles, which hold by wedging and blade compression.

(1) Blades comprise those pitons which have flat surfaces and range in size from knife-blade thickness to one-half inch.

(2) Angles are those which have rounded or V-shaped blades and allow the sharp edges to cut into the edge of a crack. Sizes vary from a short "shallow angle" of one-half inch thick and 2½ inches long to "bongs" (large angles of 4 inches in width). The leeper, a special Z-shaped angle, is designed to give greater holding power due to its cutting ability and blade compression.

(3) Pitons are made of chrome-molybdenum alloy metal which has a high strength versus weight ratio. Multiple holes further reduce the weight but do not compromise their strength. Pitons are virtually indestructible. However, they should only be used for the designed purpose. Damage may occur during the placement of a piton by ineffective or off-center hammering. Pitons must not have cracks or be bent from the shape of manufacture. Any piton which is suspected of cracks or bends should be removed from service.

j. Figure-Eight Clog. A mechanical friction device used for belaying, rappelling, and breaking while lowering personnel and equipment. The device is formed in a figure-eight (figure 22-25) with two different size openings comprising the inner holes. The rope is passed through the larger hole of the "8" and over the connecting portion of the device. The smaller hole is attached to a carabiner. The figure-eight clog is manufactured in various sizes.

k. Protection System (Belay System). This system is commonly referred to as a belay, securing of a climber tied to the end of a rope by a stationary second climber (figure 22-26A and 22-26B).

(1) The major components of the belay system are (figure 22-27):

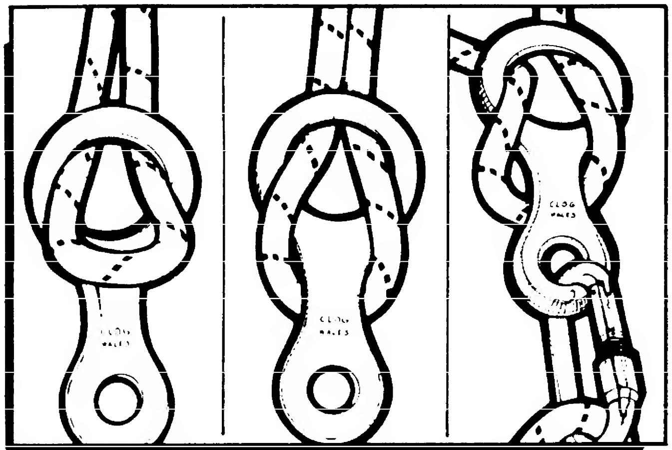


Figure 22-25. Figure-Eight Clog Direct Belay Installation.

(a) An anchor—secure point to which the belayer is attached.

(b) Belayer—individual responsible for the security of the climber.

(c) Intermediate protection point(s)—placement of slings, chocks, or pitons along the route of climb by the lead climber. The climbing rope is threaded through carabiners attached to the devices and the climbing rope clipped into the carabiner.

(d) Climbing rope size—11 mm Kernmantle or seven-sixteenths inch Goldline.

(2) The minimum equipment for a belay system is divided between rescue team and personal equipment. Rescue team equipment is comprised of the items necessary for the climbers to reach the objective. These are the climbing rope and climbing hardware, including chocks, pitons, slings, and carabiners. Individual equipment is comprised of items which allow each climber to perform belaying and climb. These equipment items are climbing helmet, seat harness, climbing boots, and gloves (worn while belaying or rappelling only).

22-6. The Successful Climb. The successful accomplishment of a climb is based on the strict application of basic principles and techniques.

a. Route Selection. Route selection can be the deciding factor in planning a climb. A direct line is seldom the proper route from a given point to the area of the survivor. Time spent at the beginning of the climbing operation in proper route selection may save a large amount of time once the operation has started. The entire route must be planned before it is carried out, with the safest route selected. Natural hazards present,

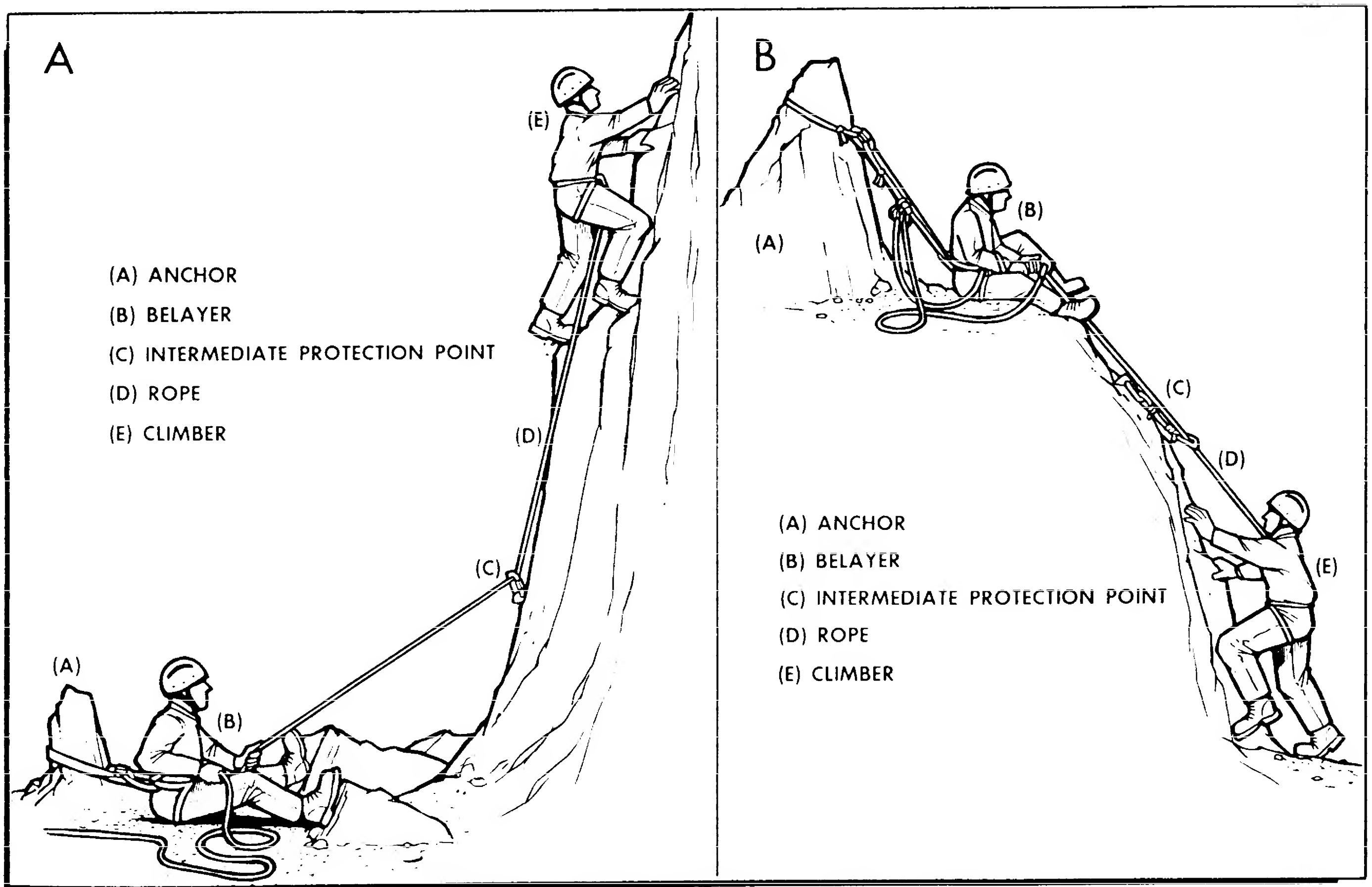


Figure 22-26. Belay System (A) Bottom (B) Top.

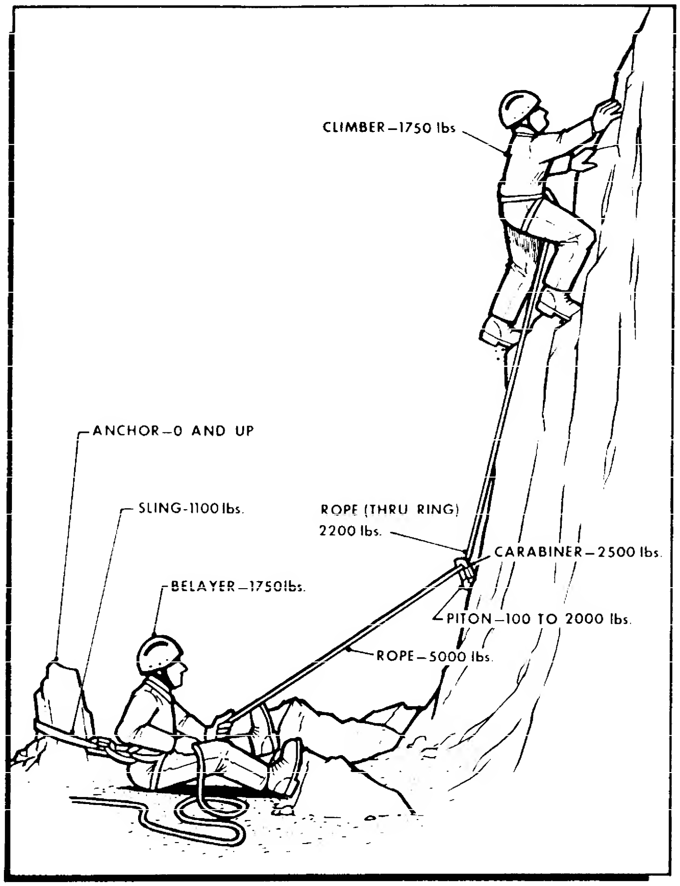


Figure 22-27. Belay Chain.

retreat routes available, time involved to perform the climb, and logistics will be major influencing factors in selecting the route.

b. Lead Climber Techniques. The lead climber is responsible for following the preplanned route of climb and altering the route as necessary. If the route of climb must be altered, consideration must be given to the experience of the climber(s). Climbing moves which are considered easy for the leader may be difficult for the second climber. Additionally, lead climbers must provide for their own personal protection during climbs to minimize the distance of a possible fall. Each intermediate protection point placed must be secure and follow as direct a line as possible.

c. Protection Placement. The basic principle to placement of protection is to decrease the distance of a fall. If the protection is not placed at frequent intervals, the climber's descent during a fall will equal twice the distance from the climber to the belayer. Slack in the belay system and rope stretch will slightly increase the distance. If a leader climbed 90 feet above the belayer without adding protection, the resultant fall will be 180 feet plus slack and stretch (figure 22-28). The belayer is helpless to stop the leader's fall in this situation. However, providing protection at intervals (figure 22-28) of 15, 20, and 25 feet, for example, will decrease the distance of a leader's fall to a little over 30 feet, making it easier for the belayer to stop the fall. Preferably, protection should be placed at about 10-foot intervals during all climbing operations to minimize the distance of a fall.

(1) The leader can reduce the drag on the rope by climbing in as straight a line as possible through protection points. The zigzagging of the climbing rope through protection points widely spaced or at abrupt angles (figure 22-29) will increase rope drag. Ideally, when points of protection are separated, a sling should be added to the anchor to keep the climbing rope in a straight line (figure 22-29). The attachment of a sling to an intermediate protection device is called a runner.

(2) Chocks on wire should always have a runner placed on the wire as shown in figure 22-30. The runner reduces the direct rope movement of the wired chock, thereby reducing possible dislodgment. For all wired and roped chocks, runners should be clipped into a carabiner at the chock, and the climbing rope clipped into an additional carabiner.

(3) Pitons may also be extended in a similar manner to that used for chocks. If sufficient runners are not available on long climbs, a chock sling may be used. The climbing leader must correctly thread the climbing rope through the carabiners attached to the piton. The carabiner should open either down and out or toward the belayer. Further, the rope running through the carabiner should run from the inside to the outside to prevent binding or the carabiner gate from opening.

d. Leader Belay. The length of the climbing rope or the length of the route climbed will determine when a belay will be established by the leader. If the route is longer than a rope length, a belay must be established by the leader to protect the first belayer's ascent to the leader's position. The belay chain is established as shown in figure 22-31. The only alteration necessary to the belay chain would be if the second climber continued the climb as the leader once the belayer's (first leader's) position is reached. This leap frogging of the leader is referred to as "climbing through". The sequence for the climbing through method begins when the first leader reaches the end of the climbing rope length. The leader selects a suitable belay position when the belayer (second climber) states that approximately 20 feet of rope remain. With a suitable site selected, one that has anchor and an area for a standing or sitting belay, the lead climber belays. The second climber then climbs up to the lead climber. Once reaching the lead climber, the second climber assumes the lead climber's role and continues the climb.

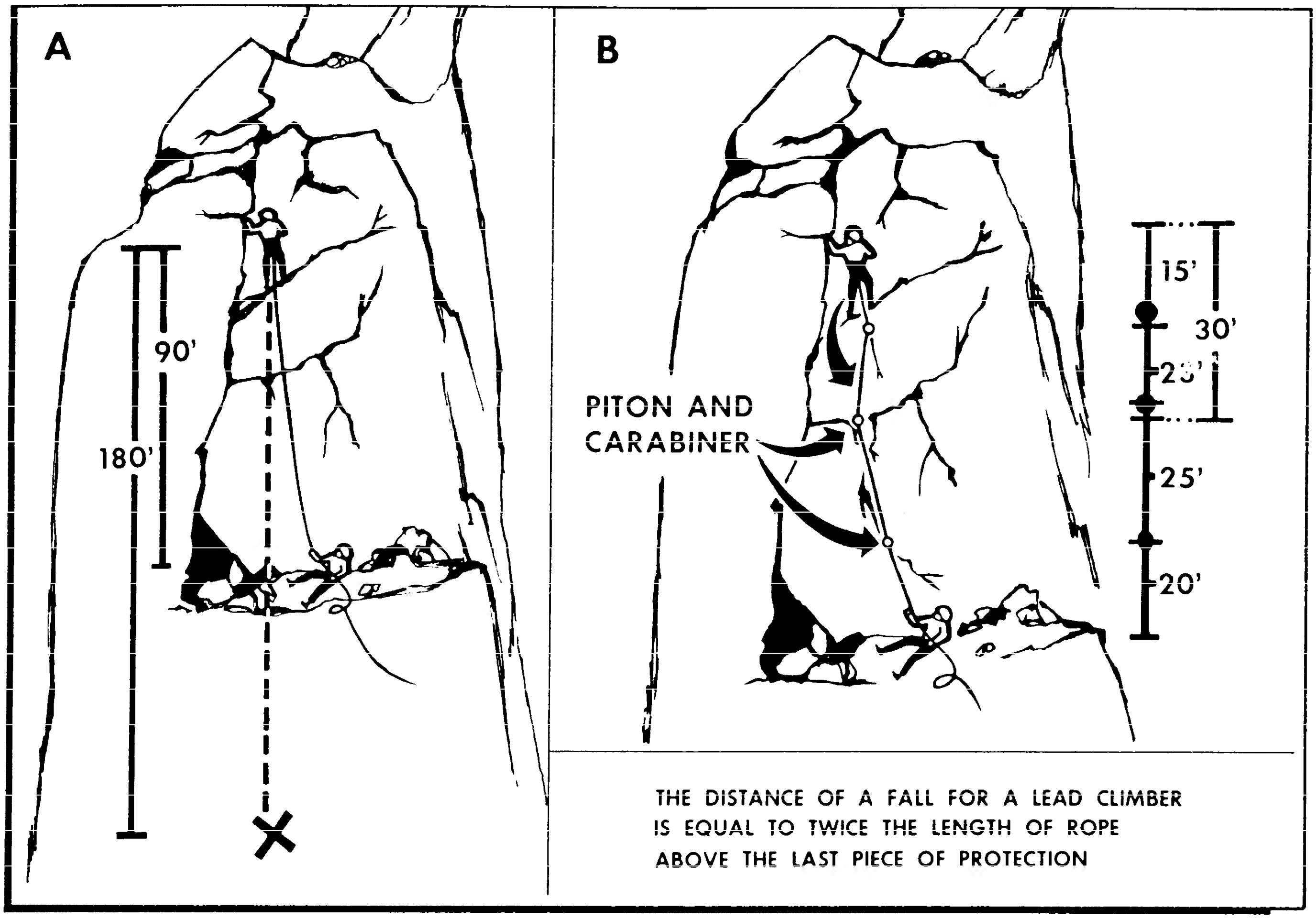


Figure 22-28. Protection Placement.

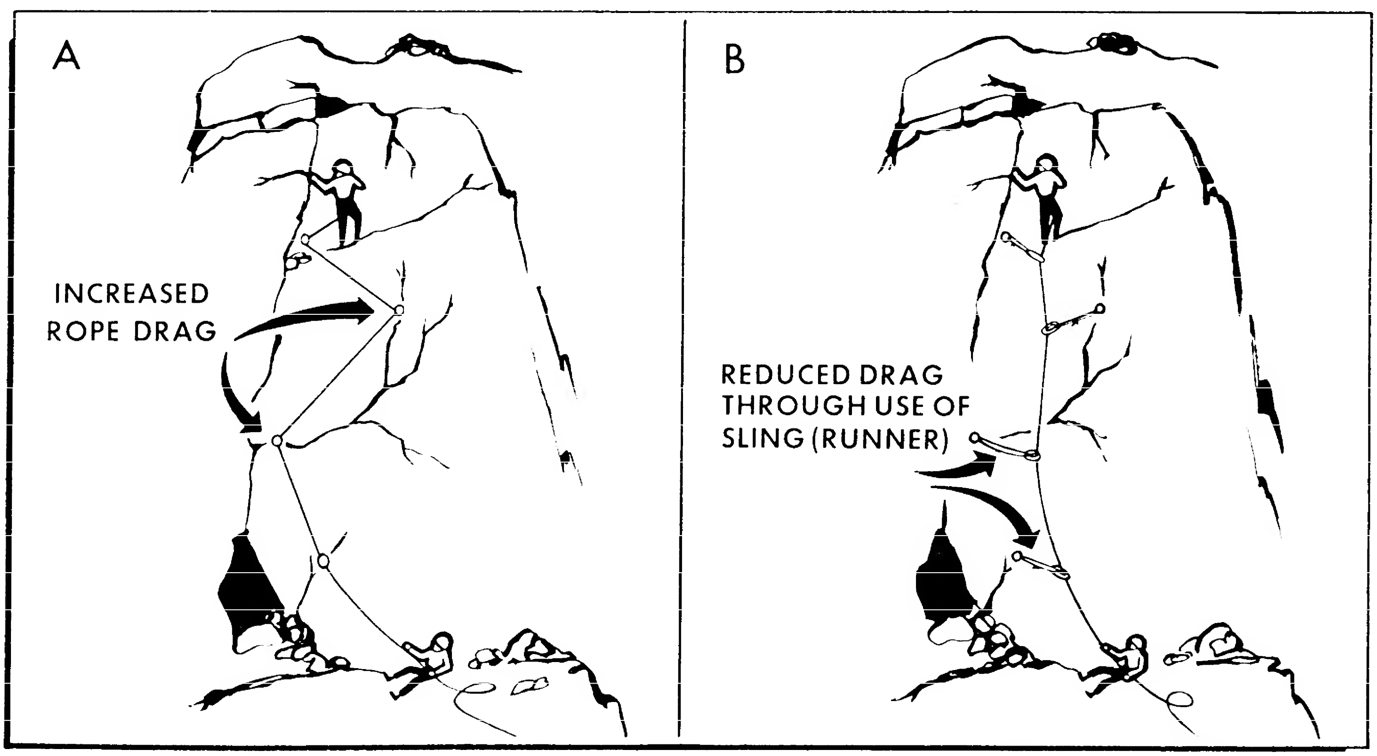


Figure 22-29. Direct Placement.

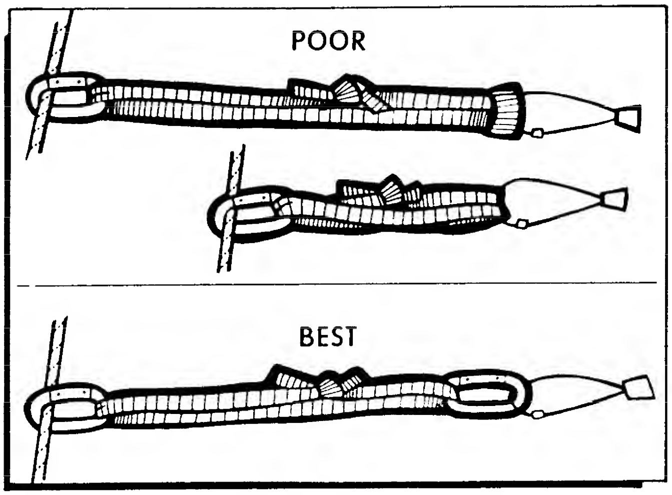


Figure 22-30. Runner Placement on Chocks.

(1) Terrain must be analyzed to find an efficient route of travel. The rescuer (climber) must make a detailed reconnaissance, noting each rock obstacle, the best approach, height, angle, type of rock, difficulty, distance between belay positions, amount of equipment, and number of trained rescuers needed to accomplish the mission on or beyond the rocks. If the strata dips toward the rescuer, holds will be difficult as the slope will be the wrong way. However, strata sloping away from the rescuer and toward the mountain mass provides natural stairs with good holds and ledges.

(2) At least two vantage points should be used so a three-dimensional understanding of the climb can be attained. Use of early morning or late afternoon light, with its longer shadows, is helpful in this respect. Actual ground reconnaissance should be made, if possible.

e. Dangers to Avoid:

(1) On long routes, changing weather will be an important consideration. Wet or icy rock can make an otherwise easy route almost impassable; cold may reduce climbing efficiency; snow may cover holds. A weather forecast should be obtained if possible. Smooth rock slabs are treacherous, especially when wet or iced after freezing rain. Ledges should then be sought. Rocks overgrown with moss, lichens, or grass become treacherous when wet. Under these conditions, cleated boots are by far better than composition soles.

(2) Tufts of grass and small bushes that appear firm may be growing from loosely packed and unanchored soil, all of which may give way if the grass or bush is pulled upon. Grass and bushes should be used only for balance by touch or as push holds—never as pull holds. Gently inclined but smooth slopes of rock may be covered with pebbles that may roll treacherously underfoot.

(3) Ridges can be free of loose rock, but topped with unstable blocks. A route along the side of a ridge just below the top is usually best. Gullies provide the best protection and often the easiest routes, but are more subject to rockfalls. The side of the gully is relatively free from this danger. Climbing slopes of talus, moraines, or other loose rock are not only tiring to the individual but dangerous because of the hazards of rolling rocks to others in the party. Rescuers should close up intervals when climbing simultaneously. In electrical

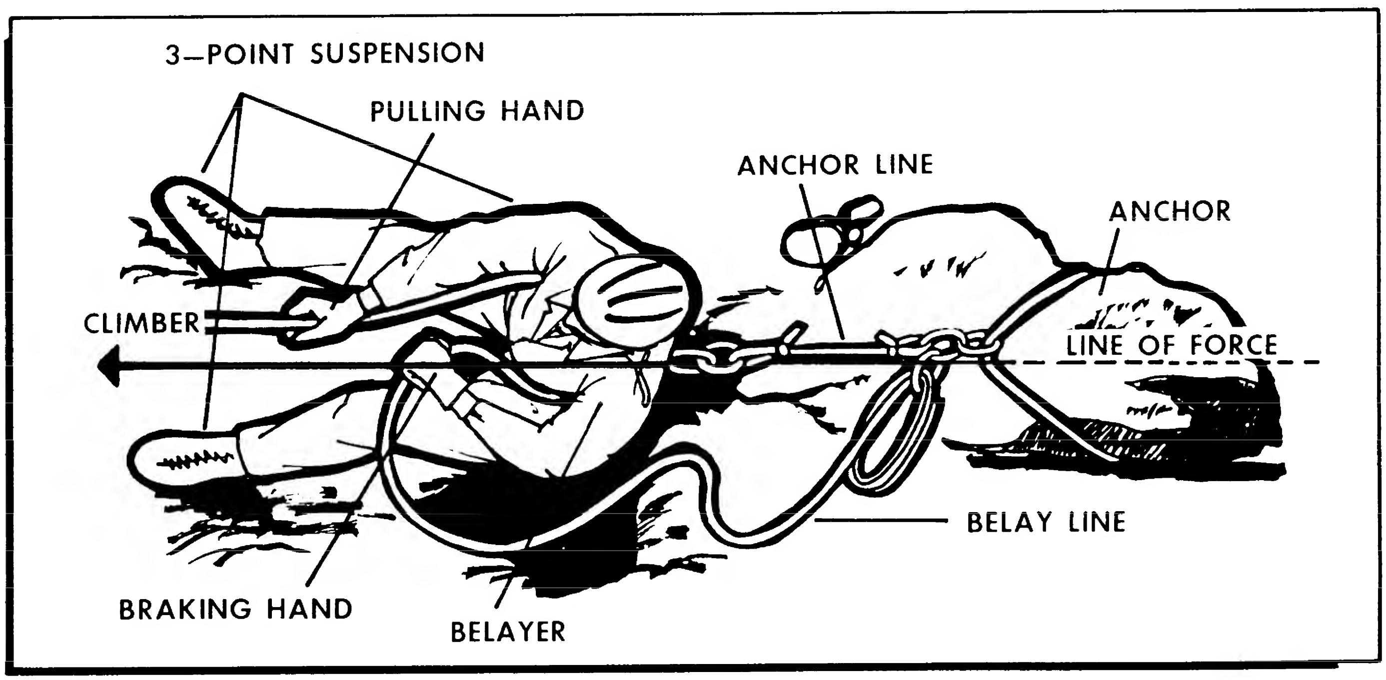


Figure 22-31. Belay Chain.

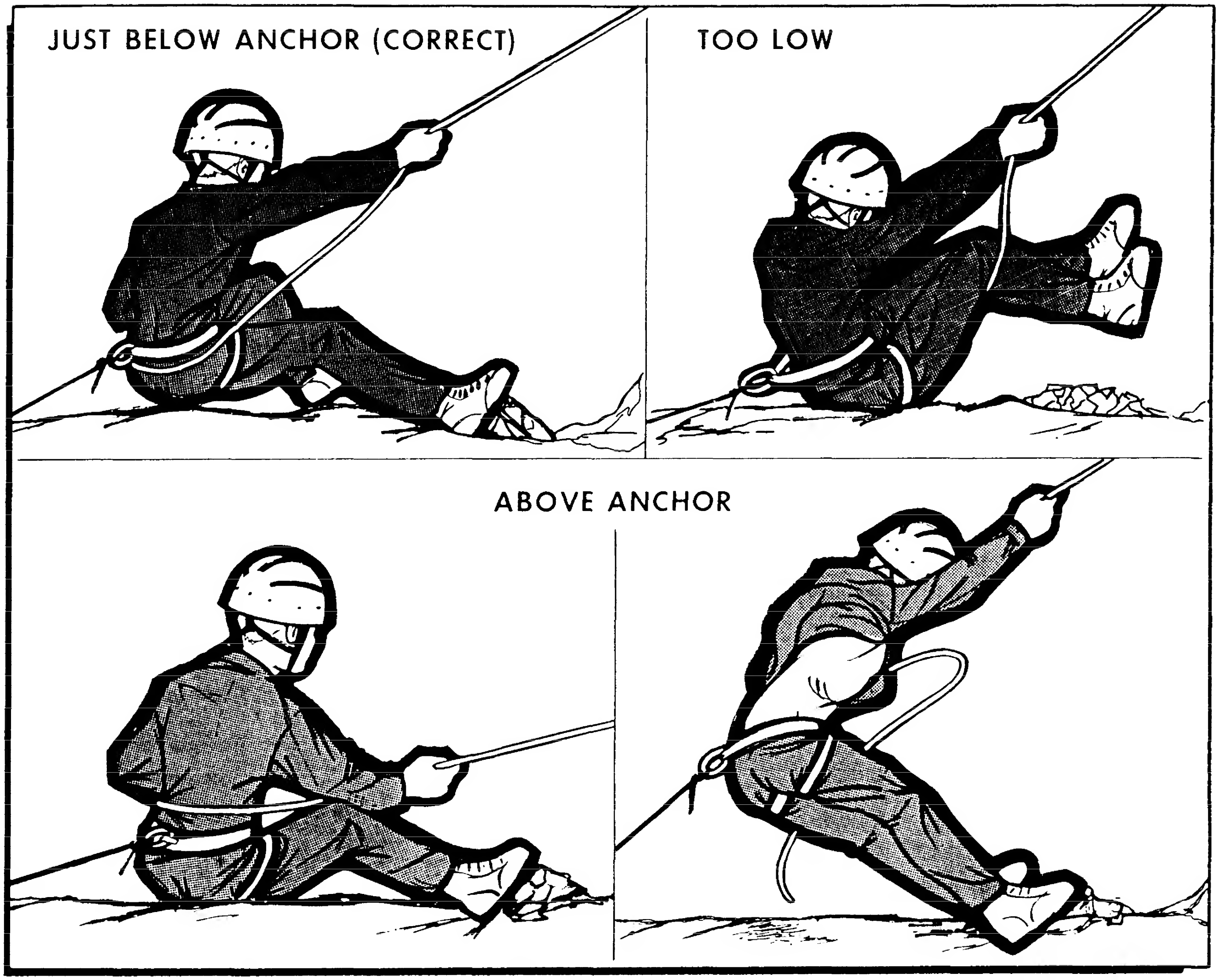


Figure 22-32. Sitting Belay.

storms, lightning can endanger the climber. Peaks, ridges, pinnacles, and lone trees should be avoided.

(4) Rockfalls are the most common mountaineering danger. The most frequent causes of rockfalls are other climbers, heavy rain and extreme temperature changes in high mountains, and resultant splitting action caused by intermittent freezing and thawing. Warning of a rockfall may be the cry "ROCK," a whistling sound, a grating sound, a thunderous crashing, or sparks where the rocks strike at night. A rockfall can be a single rock or a rockslide covering a relatively large area. Rockfalls occur on all steep slopes, particularly in gullies and chutes. Areas of frequent rockfalls may be indicated by fresh scars on the rock walls, fine dust on the talus piles, or lines, grooves, and rock-strewn areas on snow beneath cliffs. Immediate action is to seek cover, if possible. If there is not enough time to avoid the rockfall, the climber should lean into the slope to minimize exposure. Danger from falling rock can be minimized by careful climbing and route selection. The route selected must be commensurate with the ability of the least experienced team member. (NOTE: Yell "rock" when equipment is dropped.)

22-7. Belaying:

a. Belaying provides the safety factor or tension, which enables the party to climb with greater security. Without belaying skill, the use of rope in party climbing is a hazard. When climbing, a climber is belayed from above or below by another rescue team member.

(1) The belayer must run the rope through the guiding hand, which is the hand on the rope running to the climber or rescuer, and around their body to the brake hand, making certain that it will slide readily. The belayer must ensure that the remainder of the rope is laid out so it will run freely through the braking hand.

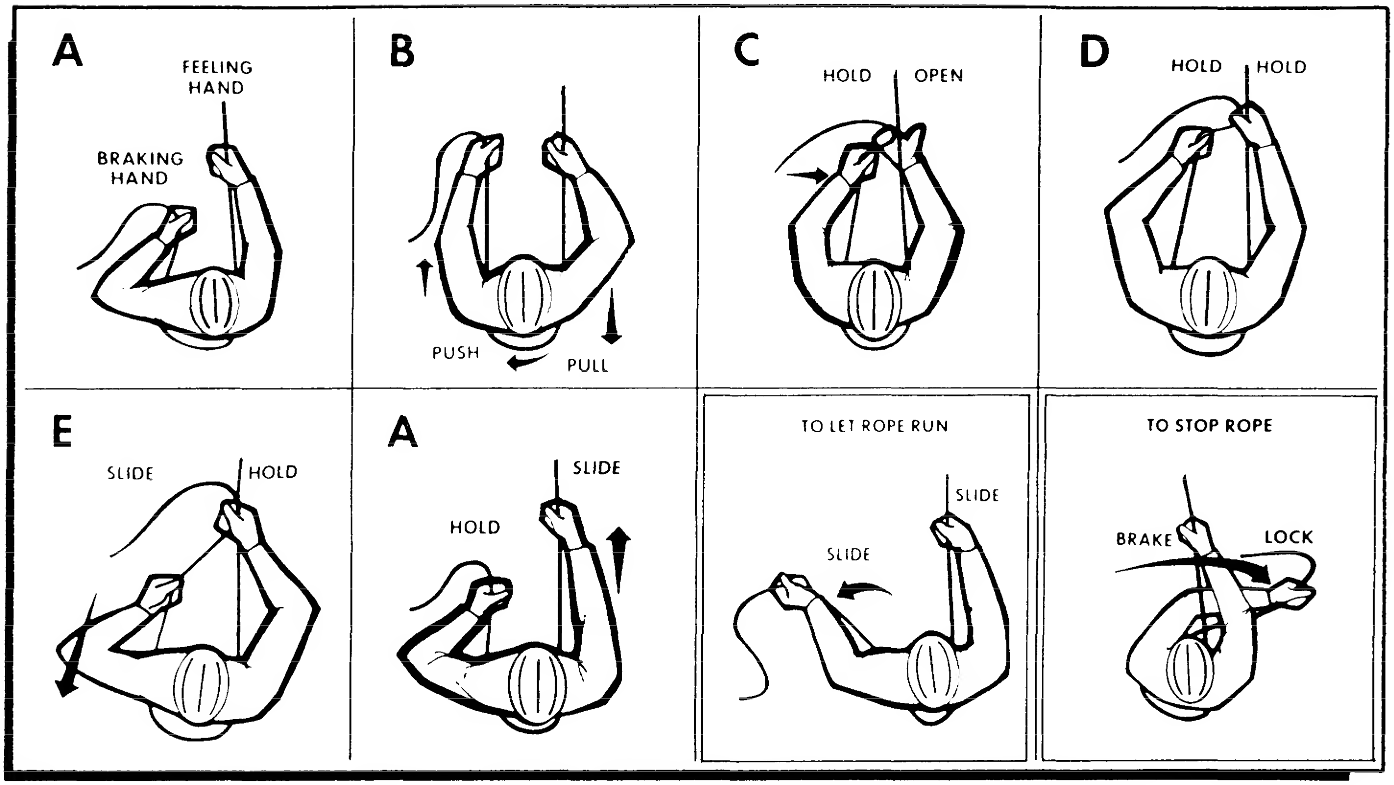


Figure 22-33. The Belay Sequence.

(2) The belayer must constantly be alert to the climber's movements in order to anticipate any needs. Avoid letting too much slack develop in the rope through constant use of the guiding hand. Keep all slack out of the rope leading to the rescuer, thus sensing any movement. If belaying a lead climber, the climber will need a constant flow of slack while climbing. If the rope is fed too slow or fast, the climber must communicate with the belayer to adjust the rate. Avoid taking up slack too suddenly to prevent throwing the climber off balance. When taking up slack, the braking hand is not brought in front of the guiding hand, but just behind the guiding hand. This allows the braking hand to slide back and to remain constantly on the rope. The braking hand is never removed from the rope during a belay.

(3) The belayer should brace well for the expected direction of pull in a fall so the force of the pull will, when possible, pull the belayer more firmly into position. A climber should neither trust nor assume a belay position which has not been personally tested.

b. The sitting belay is normally the most secure and preferred position (figure 22-32).

(1) The belayer sits and attempts to get good triangular bracing position with the legs and buttocks. Legs should be straight when possible, and the guiding hand must be on the side of the better braced leg. The rope should run around the hips. If the belay spot is back from the edge of a cliff, friction of the rope will be greater and will simplify the holding of a fall, but the direction of pull on the belayer will be directly outward. The rope must not pass over sharp edges.

(2) Even with a good belay stance, if the rope is too high or too low on the back of a belayer, the belayer may be unable to hold a falling climber (figure 22-32). With the rope too high on the back of the belayer, on a bottom belay, the rope will ride up in the belayer's armpits. (NOTE: Rope should run under the anchor.) This will pull the belayer forward and off balance if a climber were to fall. If the rope is too low on the back of a belayer, the rope will be pulled under the buttocks of the belayer. (NOTE: Rope should run on top of the anchor.) This will force the belayer to attempt to stop the fall by trying to hold onto the rope.

(3) When necessary, seek a belay position that offers cover from a rockfall.

(4) If the climber falls, the belayer should be able to perform the following movements automatically.

(a) Relax the guiding hand.

(b) Apply immediate braking action. This is done by bringing the braking hand across the chest or in front of the body (figure 22-33).

c. When a falling climber has been brought to a stop, the belayer must hold until the situation is relieved.

There are different ways to do this. If the climber is alright and can safely climb onto the rock or can be lowered to a secure ledge, all is well. However, the climber may be injured, or there may be no place to which the climber can be lowered. The belayer cannot continue holding the climber. The belayer must be relieved to assist the climber in the next step. This can be done by using a prusik sling. If the belayer is alone, the braking hand will hold the static climber while the other hand is free to anchor the belay line. This particular method is only good when using a belay anchor. Follow the procedure shown in figure 22-34. Climbers who are in good condition can either prusik up or pendulum across to a ledge.

22-8. Communications. Because constant communication between the belayer and climber is essential for safety, a standard group of climbing commands must be mastered.

a. Communications while climbing must be as simple as possible and single words are preferred. Communications in the form of commands are necessary when climbing. Commands which sound alike should be avoided. The command system follows a set pattern which leads to safe climbing and ensures that belays are used. Commands should be clear, specific, and given in a loud voice. The sequence of the system should not be broken. A review of the command system should be made before any climb. The European command has all the necessary commands to ensure safety. Only one command has a reply; the other commands are answered by the next command in the system. Sounding off the next command is not done until the requirements of the prior command are complete.

b. Commands are generally climber initiated. The belayer, in each instance, acknowledges when commands are heard and understood. If the command is not understood, the belayer should not say anything. The silence indicates to the climber that the belayer doesn't know what is happening. The command must be repeated.

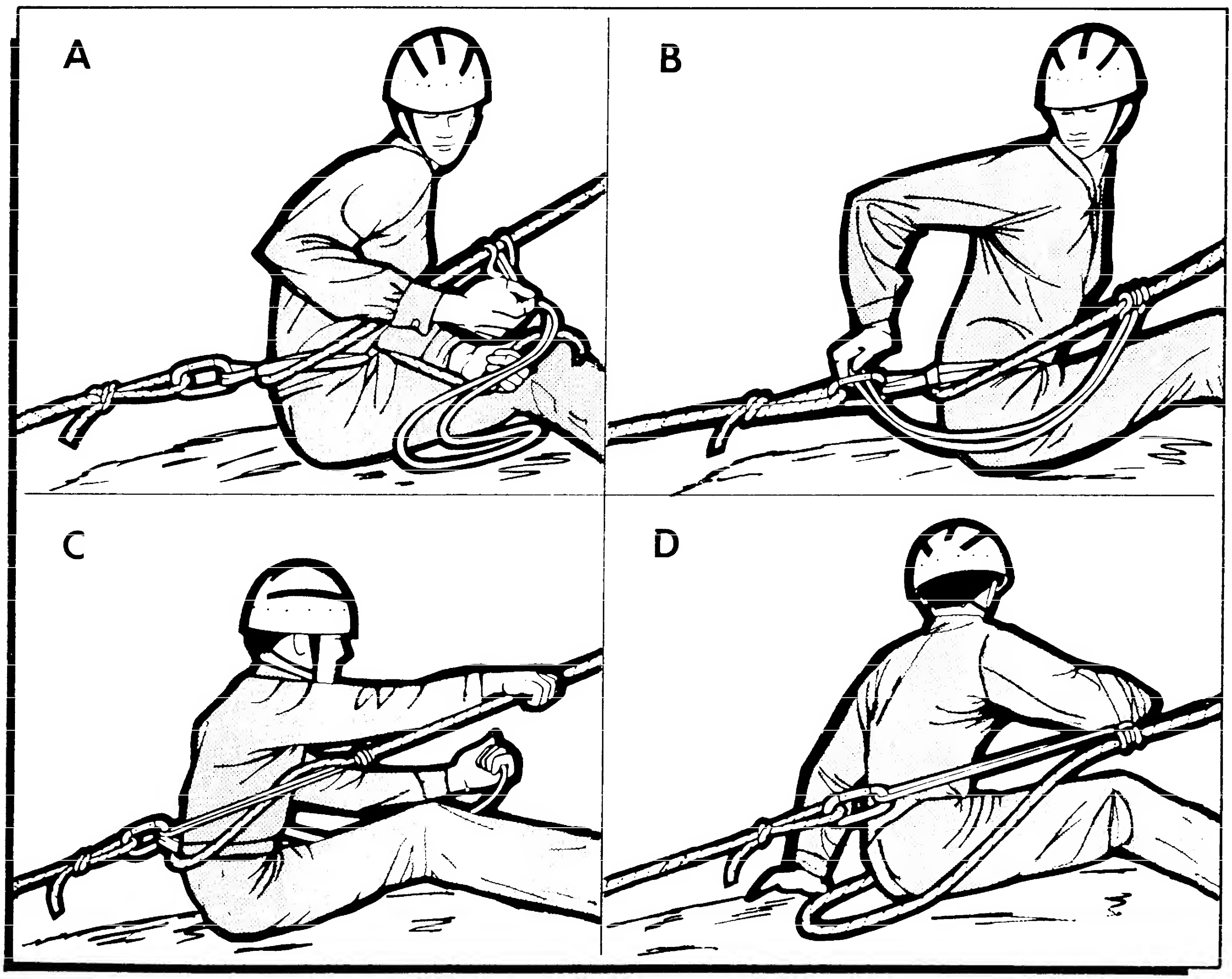


Figure 22-34. Safety Off the Belay Line.

(1) The following are the standard commands used:

(a) Initiation of a Climbing Sequence:

-1. "ON BELAY"—a signal indicating the climber is secured on the end of the rope and asks if belayer is ready.

-2. "BELAY ON"—(the belayer acknowledges the climber) means the belayer is in position and ready.

-3. "BELAY TEST"—the climber is asking to test the belay.

-4. "TEST"—signifies the belayer is ready for the climber to gradually apply weight on the rope. Releasing of the tension will indicate the test is finished.

-5. "UP ROPE"—the climber is directing the belayer to take up the slack.

-6. Belayer response: "ROPE UP."

-7. "THAT'S ME"—the climber signifies to the belayer that the tension felt on the rope is the climber.

-8. Belayer response: "THANK YOU."

-9. "CLIMBING"—the climber signifies the climber has chosen a route and is ready to climb.

-10. "CLIMB ON"—the belayer is acknowledging being ready for the climber to begin climbing. The climber will not start climbing before the command is heard.

(b) General Commands used while Climbing:

-1. "TENSION"—the climber is telling the belayer to take up all of the slack in the rope. This command is given if the climber needs assistance or there is an impending fall.

-2. Belayer responds with: "TENSION ON."

-3. "RESTING"—the climber is in a position for rest; belayer will lock brake across waist.

-4. Belayer responds with: "REST ON."

-5. When the climber begins again the command of "CLIMBING" will be given and "CLIMB ON" is given when the belayer is ready.

-6. "SLACK ___ FEET"—the climber will use this command when slack is needed in the rope to get over a difficult section or traverse. The climber should say "SLACK" and then the estimated number of feet the climber needs. Belayer will respond by repeating the number of feet of slack given. The climber will indicate that enough slack has been given by saying "THANK YOU."

-7. The command "FALLING" should be given when the climber is going to fall. This provides the belayer adequate time to apply the brake. Before continuing the climb, the climber will give the command "CLIMBING."

(c) Commands to Terminate the Climbing Sequence:

-1. "OFF BELAY"—the climber uses this command to indicate the climber is secure and through climbing.

-2. "BELAY OFF"—the belayer uses this command to indicate the brake hand is off the rope and the climber is no longer on belay.

22-9. Anchors. Anchors are secure points in the belay chain providing protection for the belayer and the climber. Anchor systems must be able to withstand high loads. The basis for any type anchor is strong, secure points for attachment.

a. Anchor Points. Anchor systems may be simple and consist of a single anchor point, or complex and consist of multiple anchor points. Anchor points are divided into two classes—natural and artificial. Anchor systems may be constructed entirely of one class, or a combination of the two.

(1) Natural Anchor Points (figure 22-35):

(a) Spike. A spike is a vertical projection of rock. For use as an anchor point, a sling is placed around the spike.

(b) Rock Bollard. A rock bollard is a large rock or portion of such a rock which has an angular surface enabling a sling or rope to be placed around it in such a manner that will not allow it to slip off. Care must be taken to ensure the bollard will not be pulled loose when subjected to a sudden load.

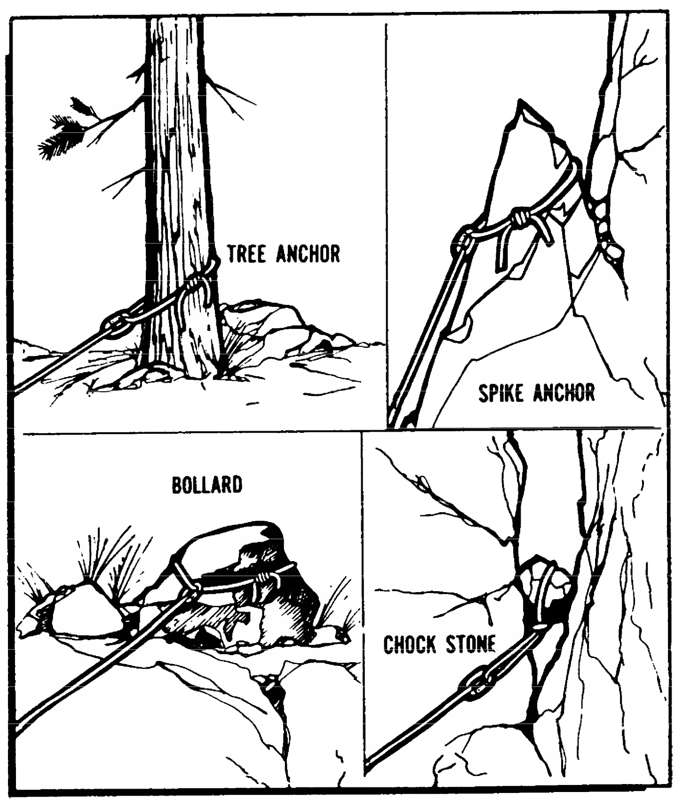


Figure 22-35. Natural Anchor Points.

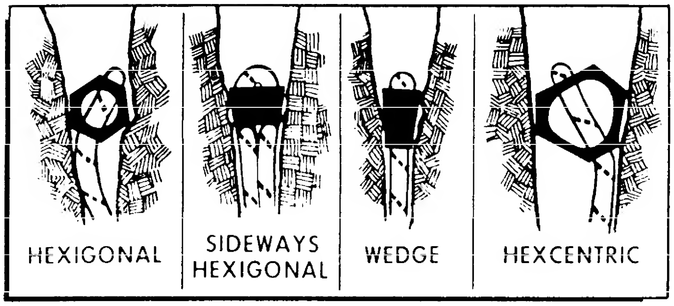


Figure 22-36. Placement of Chocks.

(c) Chockstone. A natural chockstone is a securely wedged rock providing an anchor point for a sling. In most cases, the rock is wedged within a crack.

(d) Tree. Trees often make very secure anchor points. A rope can be tied directly to the tree (or a sling doubled around the tree and connected by a carabiner). In loose or rocky soil, trees should be carefully watched and avoided if other anchor points are available.

(2) Artificial Anchor Points. Artificial anchor points are those constructed from equipment carried by the team. These are usually the chocks or pitons placed in cracks or bolts drilled in the rock.

(a) Chock Placement. The basic principle is to wedge the selected chock into a crack so that a pull in the direction of fall will not pull the chock out. The proper method is to select a crack suitable for an anchor point and select a chock to fit that crack. The chock chosen should closely fit the widest portion of the crack. Work the chock into the crack until it is securely seated. It should be seated so that the load will come on the entire chock without rotating it out of position. When the chock is in place, jerk hard on the attached sling in the direction of fall to ensure it is well seated. (Ensure the chock cannot continue to work downward to a larger area of the crack and become dislodged). A chock may also be placed so that its pull is in one direction while the second chock has a pull in the opposing direction. One sling is passed through the loop of the other chock. A force exerted downward will pull the two chocks toward each other along the axis of the crack. In vertical cracks, the lower sling should be passed through the upper for best results. The two chocks should be placed far enough apart so neither sling will reach the other chock. Figure 22-36 shows the various types of chocks

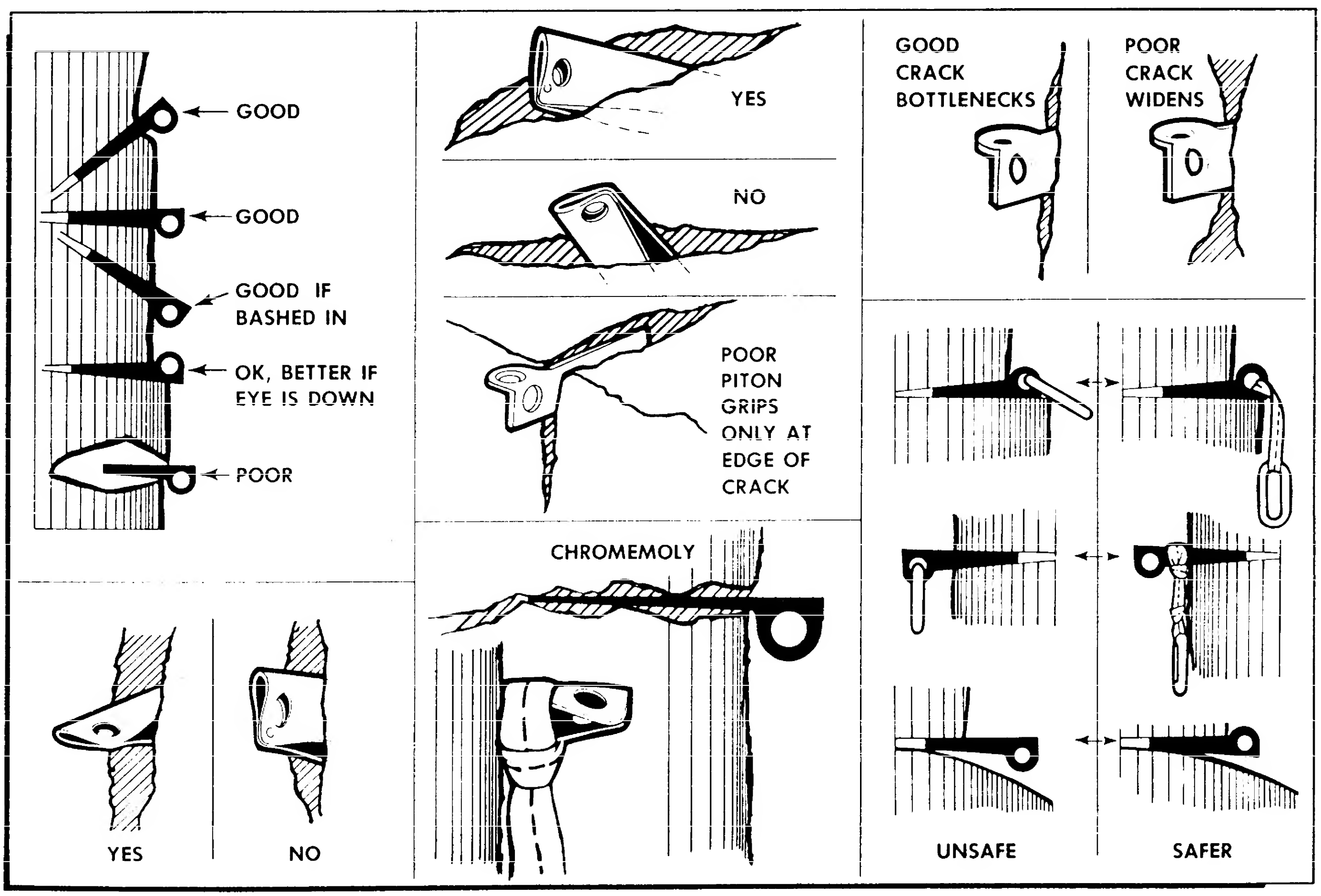


Figure 22-37. Placement of Pitons.

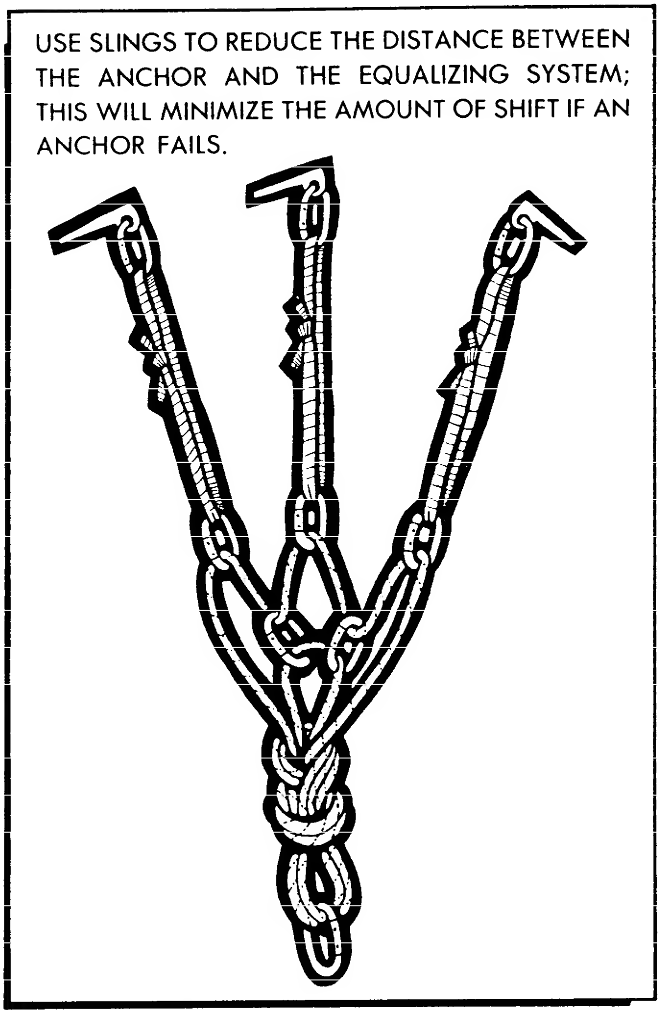


Figure 22-38. Equalizing Anchor.

and their placement. (NOTE: Chocks are preferred over pitons and bolts since they do not deface the rock.)

(b) Piton Placement. Basically, the use of pitons is a matter of locating a crack, selecting a piton which fits, driving the piton in, clipping a carabiner to the eye, and attaching the rope system to the carabiner.

-1. First look at the crack to decide the best position for driving the piton. The piton should be driven into the wider portion of the crack to reduce the likelihood of shifting or rotating under pressure. The crack must not widen or flare internally and not have a change in direction of more than 15 to 20 degrees.

-2. Before driving, the piton should fit one-half to two-thirds of the blade length into the crack. Drive until only the eye protrudes or the piton meets resistance. Do not attempt to overdrive the piton because it may fracture. Lightly tap the piton to test for movement or improper seating. If movement is noted, remove the piton and replace it with the next larger size or locate another anchor position. The proper placement of pitons in horizontal cracks is with the eye down. If the piton cannot be driven into the rock until only the eye protrudes, it may be tied off by placing a short sling around the piton with a girth or clove hitch as close to the rock as possible. In this case, the sling should be used as the attachment point and not the eye of the piton. Figure 22-37 shows the proper placement of pitons.

b. Anchor System. The purpose of an anchor system is to unite weak anchor points into a strong anchor system. Systems are divided into two classes—equalizing and nonequalizing.

(1) Equalizing systems are constructed so that if there is a change in direction of the load, the stress will be equally distributed to all anchor points. One major problem with this system is that if one point fails, the remaining points will be shock loaded (figure 22-38).

(2) Nonequalizing systems are constructed when a change of direction is not expected. The major advantage is the entire load is shared by the anchor points equally and would require the entire system to fail before coming loose. Any multipoint anchor system tied together so the attaching rope does not slip would be considered nonequalizing.

22-10. Climbing:

a. Balance Climbing. Balance climbing is the type of movement used to climb rock faces. It is a combination of the balance movement of a tightrope walker and the unbalanced climbing of a person ascending a tree or ladder. During the process of route selection, the climber should mentally climb the route to know what is expected. Climbers should not wear gloves when balance climbing.

(1) Body Position. The climber must keep good balance when climbing (the weight placed over the feet during movement). (See figure 22-39.) The feet, not the hands, should carry the weight (except on the steepest cliffs). The hands are for balance. The feet do not provide proper traction when the climber leans in toward the rock. With the body in balance, the climber moves with a slow, rhythmic motion. Three points of support, such as two feet and one hand, are used when possible. The preferred handholds are waist to shoulder high. Resting is necessary when climbing because tense muscles tire quickly. When resting, the arms should be kept low where circulation is not impaired. Use of small intermediate holds is preferable to stretching and clinging to widely separated big holds. A spread-eagle position, where a climber stretches too far (and cannot let go), should be avoided.

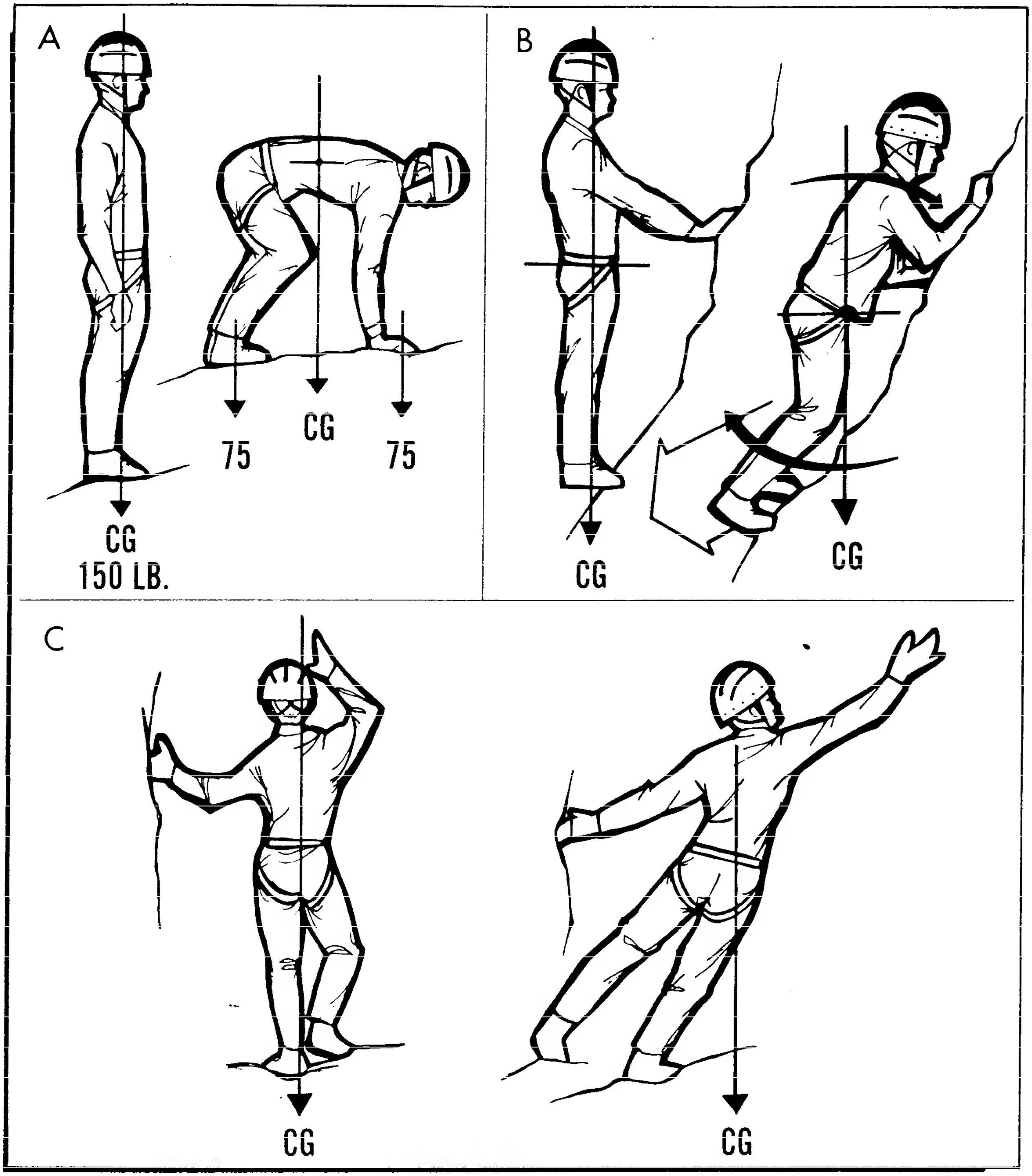


Figure 22-39. Body Position.

(2) Types of Holds:

(a) Push Holds. Push holds are desirable because they (figure 22-40) help the climber keep the arms low; however, they are more difficult to hold onto in case of a slip. A push hold is often used to advantage in combination with a pull hold.

(b) Pull Holds. Pull holds (figure 22-41) are those that are pulled down upon and are the easiest holds to use. They are also the most likely to break out.

(c) Jam Holds. Jam holds (figure 22-42) involve jamming any part of the body or extremity into a crack. This is done by putting the hand into the crack and clenching it into a fist or by placing the arm into the

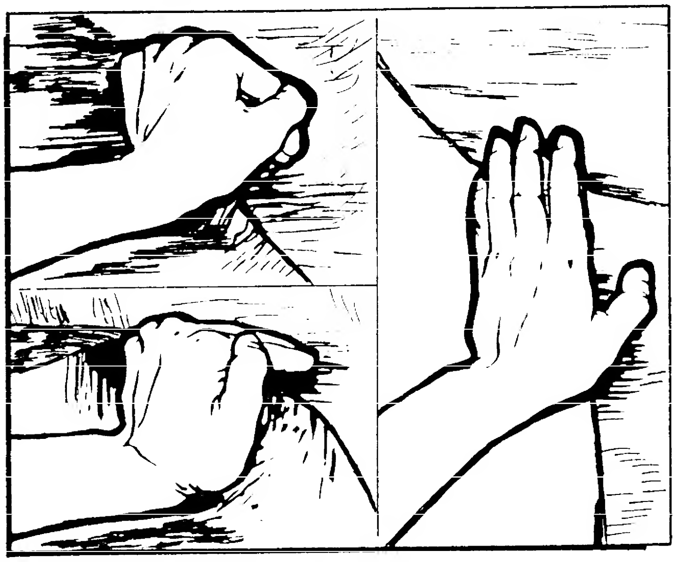


Figure 22-40. Push Holds.

-2. The lay-back (figure 22-44) is done by leaning to one side of an offset crack with the hands pulling and the feet pushing against the offset side. Lay-backing is a classic form of force or counterforce where the hands and feet pull and push in opposite directions enabling the climber to move up in a series of shifting moves. It is very strenuous.

-3. Underclings (figure 22-45) permit cross pressure between hands and feet.

-4. Mantleshelving, or mantling, takes advantage of down pressure exerted by one or both hands on a slab or shelf. By straightening and locking the arm, the body is raised, allowing a leg to be placed on a higher hold (figure 22-46).

(e) Chimney Climb. This is a body-jam hold used in very wide cracks (figure 22-47). The arms and legs are used to apply pressure against the opposite faces of the

crack and twisting the elbow against one side and the hand against the other side. When using the foot in a jam hold, care should be taken to ensure the boot is placed so it can be removed easily when climbing is continued.

(d) Combination Holds. The holds previously mentioned are considered basic and from these any number of combinations and variations can be used. The number of these variations depends only on the limit of the individual's imagination. Following are a few of the more common ones:

-1. The counterforce (figure 22-43) is attained by pinching a protruding part between the thumb and fingers and pulling outward or pressing inward with the arms.

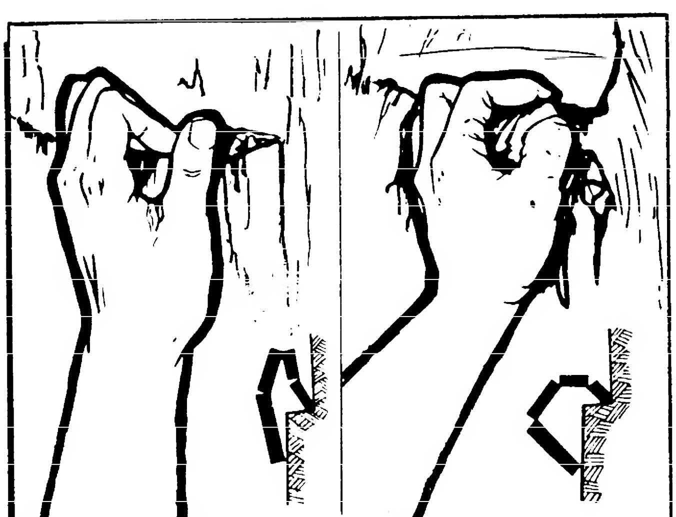


Figure 22-41. Pull Holds.

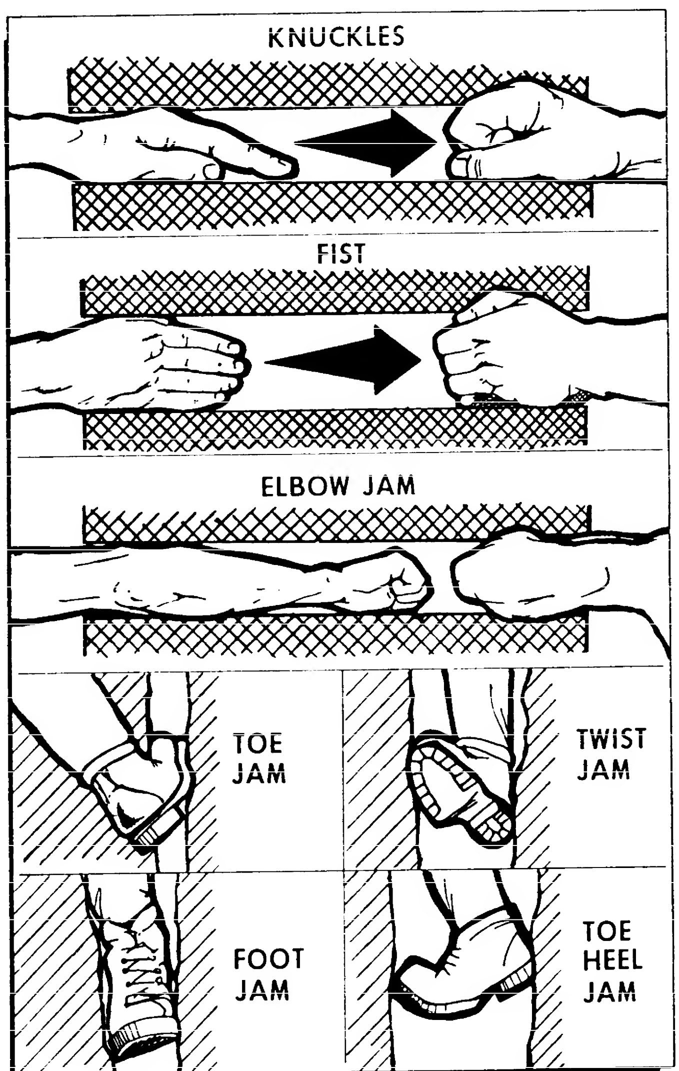


Figure 22-42. Jam Holds.

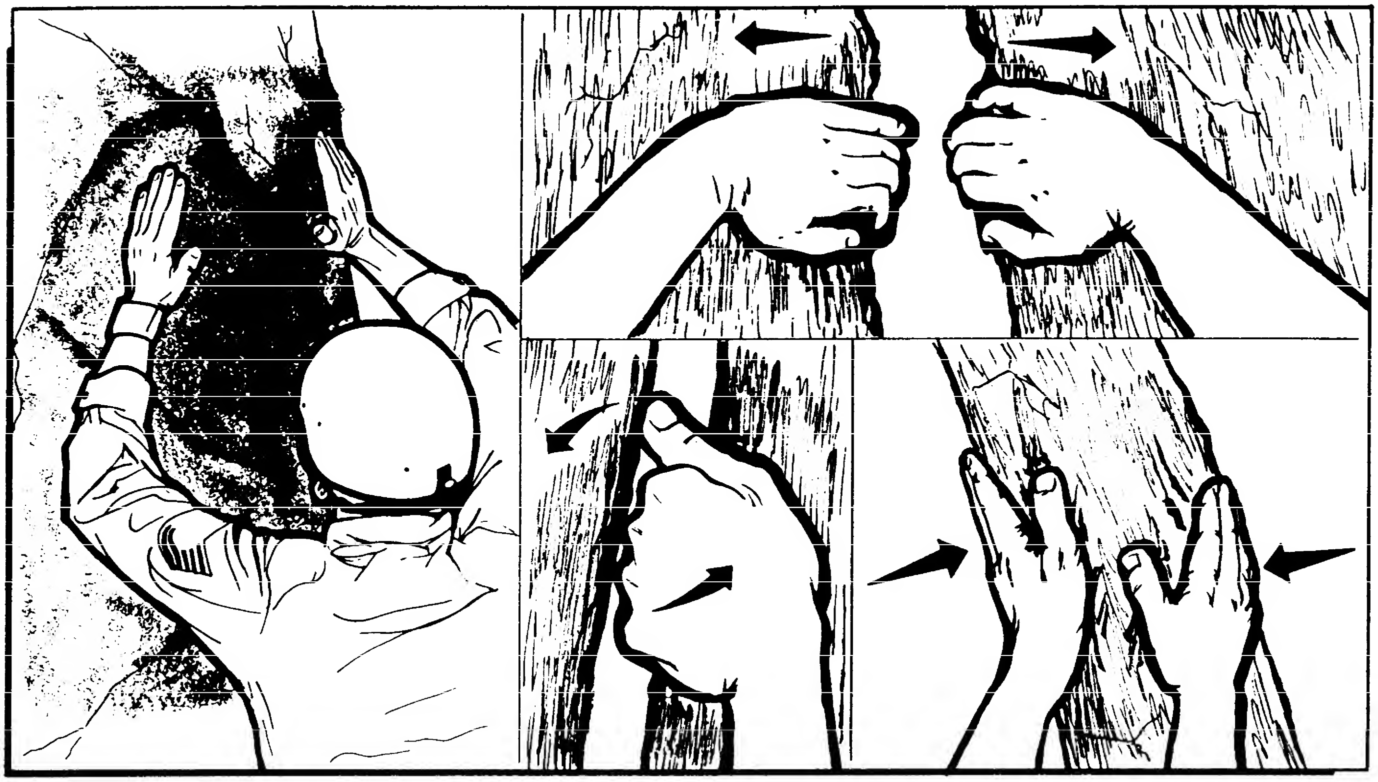


Figure 22-43. Combination Holds.

rock in a counterforce move. The outstretched hands hold the body while the legs are drawn as high as possible. The legs are flexed forcing the body up. This procedure is continued as necessary. Another method is to place the back against one wall and the legs and arms against the other and "worm" upward (figure 22-47).

b. Friction Climbing:

(1) A slab is a relatively smooth portion of rock lying at an angle. When traversing, the lower foot is pointed slightly downhill to increase balance and friction of the foot. All irregularities in the slope should be used for additional friction. On steep slabs, it may be necessary to squat with the body weight well over the feet with hands used alongside for added friction. This position may be used for ascending, traversing, or descending. A slip may result if the climber leans back or lets the buttocks down. Wet, icy, mossy, or a scree-covered slab is the most dangerous.

(2) Friction holds (figure 22-48) depend solely on the friction of hands or feet against a relatively smooth surface with a shallow hold. They are difficult to use because they give a feeling of insecurity which the inexperienced climber tries to correct by leaning close to the rock, thereby increasing the insecurity. They often serve well as intermediate holds, giving needed support while the climber moves over them; however, they would not hold if the climber decided to stop.

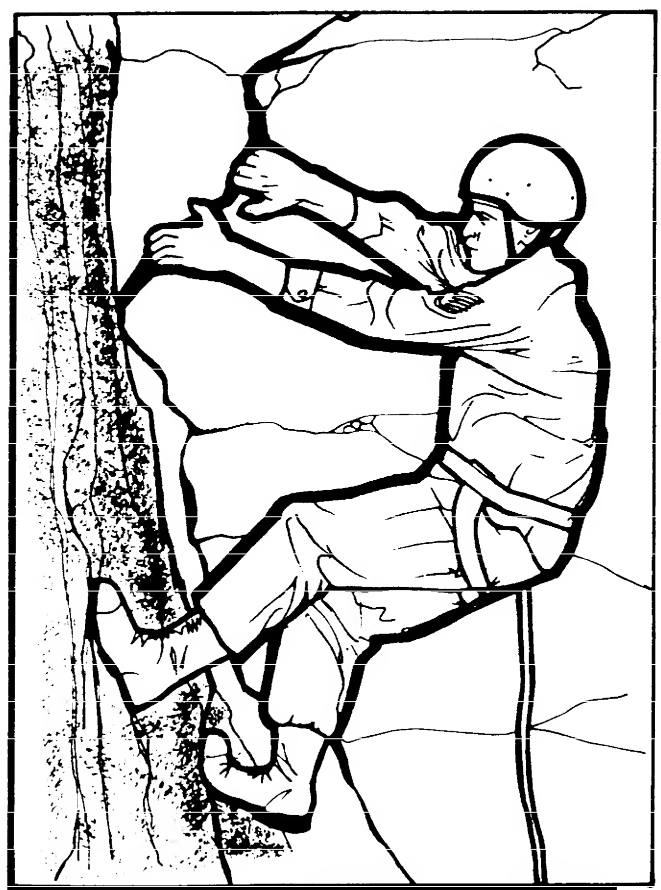


Figure 22-44. Lay-Back.

Figure 22-45. Underclings.

c. Prusik Climbing. Prusiking is a method of ascension using a fixed rope (figure 22-49). This method does not require a belay. With two prusik slings, a chest prusik sling, and a carabiner, a person can climb the length of a fixed rope. The slings are attached with prusik knots that grip tightly when loaded yet slide when the load is removed. Prusiking is strenuous and requires the use of both hands and both feet, hence it is no system for a badly injured person. Prusik slings are usually made from lengths of 7 mm Kernmantle or Mountain-Lay rope. Smaller diameter rope is less bulky and grips the climbing rope better, but in practice the knots are very difficult to work with gloved hands and is not recommended. To allow the climber to make maximum steps up with each foot in turn, the longer foot sling should extend to about nose level and the other to several inches below the waist loop. Both prusicks should have loops just big enough for the foot. The chest sling is just long enough to keep the climber from toppling backwards when rigged. Standing upright with all the weight bearing on the foot slings, the climber lifts one foot and raises its unweighted knot. Now, stepping up and shifting weight onto this sling, it is repeated with the other foot. The climb is less tiring when the foot slings are of different lengths, allowing the climber to take equal steps with both feet. There is some difficulty in sliding the knots when the rope is wet or the slings are made from laid rope. Spinning is also a potential problem under overhangs where the wall cannot be touched to maintain stability, particularly when climbing a laid rope. While a rescuer (climber) is ascending via the prusik method, companions have little to do except guard the anchors and prepare to lift the climber over the edge.

22-11. Rappelling. The climber with a rope can descend quickly by sliding down a rope which has been doubled around such anchor points as a tree, a projecting rock, or several artificial anchors secured to each other with sling rope.

a. Establishing a Rappel. In selecting the route, the climber should be sure the rope reaches the bottom or a place from which further rappels or climbing can be done. The rappel point should be carefully tested, and inspected to ensure the rope will run around it when one end is pulled from below and the area is clear of loose rocks. If a sling rope is used for a rappel point, it should be tied twice to form two separate loops. The first person down chooses a smooth route for the rope which is free of sharp rocks. Place loose rocks, which the rope might later dislodge, far enough back on ledges to be out of the way. The rappeler should ensure the rope runs freely around the rappel point when pulled from below. Each person down will give the signal "OFF RAPPEL," straighten the rope, and ensure the rope runs freely around its anchor. When silence is needed, a prearranged signal of pulling on the rope is substituted for the vocal signal. Recover the rope when the last person is down. The rope should be pulled smoothly to prevent the rising end from whipping around the rope. Climbers should stand clear of falling rope and rocks which may be dislodged. The rope should be inspected frequently if a large number of people are rappelling. Rappellers should wear gloves during rappels to protect the palms from rope burns.

b. Types of Rappel. The type of rappel is determined by the steepness of the terrain. The hasty rappel is used only on moderate pitch slopes. The body rappel may be used on moderate to severely pitched slopes, but never

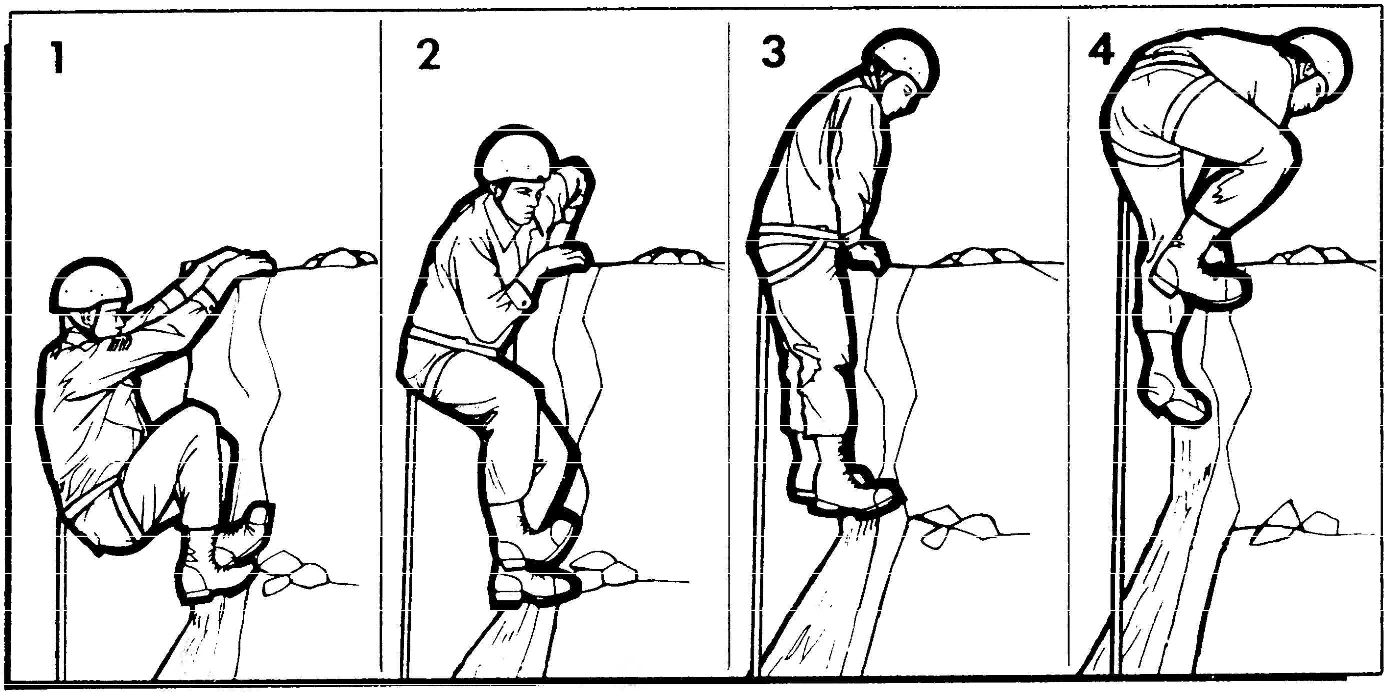


Figure 22-46. Mantleshelving.

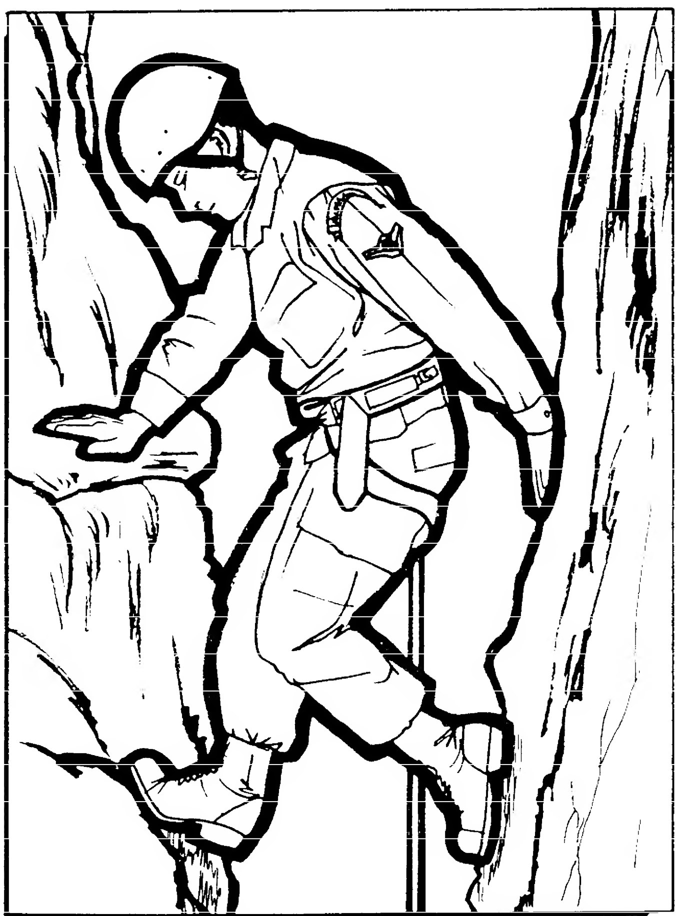


Figure 22-47. Chimney Climbing.

Figure 22-48. Friction Holds.

Figure 22-49. Prusiking.

used on overhangs. The seat rappel is used on very steep pitches, including overhangs.

(1) The Hasty Rappel (figure 22-50). Facing slightly sideways to the anchor, the climber places the ropes across the back. The hand nearest the anchor is the guiding hand. To stop, the rappeller brings the braking hand across in front of the body, and at the same time turns to face the anchor point.

(2) The Body Rappel (figure 22-51). The climber faces the anchor point and straddles the rope; then pulls the rope from behind, runs it around either hip, diagonally across the chest, and back over the opposite shoulder. From there the rope runs to the braking hand which is on the same side of the hip that the rope crosses (for example, the right hip to the left shoulder to the right hand). The climber should lead with the braking hand down and should face slightly sideways. The foot corresponding to the braking hand should precede the other at all times. The guiding hand should be used only to guide and not to brake. To rappel, lean out at a 45-degree angle to the rock. Keep the legs well spread and relatively straight for lateral stability, and the back straight since this reduces unnecessary friction. The collar should be turned up to prevent rope burns on the neck. Gloves should be worn and any other articles of clothing may be used as padding for the shoulders and buttocks. To brake, lean back and face directly into the rock so the feet are flat on the rock.

(3) Four-Carabiner Seat Rappel. Seat rappels differ from the body and hasty rappels in that the friction is primarily absorbed by a carabiner in the sling rope seat worn by the rappeller. The rappeller stands to one side of the rope (when braking with the right hand on the left and when braking with the left hand on the right). Some slack between the carabiner and the anchor point is taken up and brought through two carabiners which are attached to the harness and are horizontal and reversed and opposed (figure 22-52). Two additional carabiners are clipped from opposite sides, gates down, at 90 degrees to the original carabiners to form a friction brake bar (figure 22-53).

c. Body Position. The body must be perpendicular to the face of the rock, and the feet must be about shoulder width apart and flat on the rock (figure 22-54). To de-

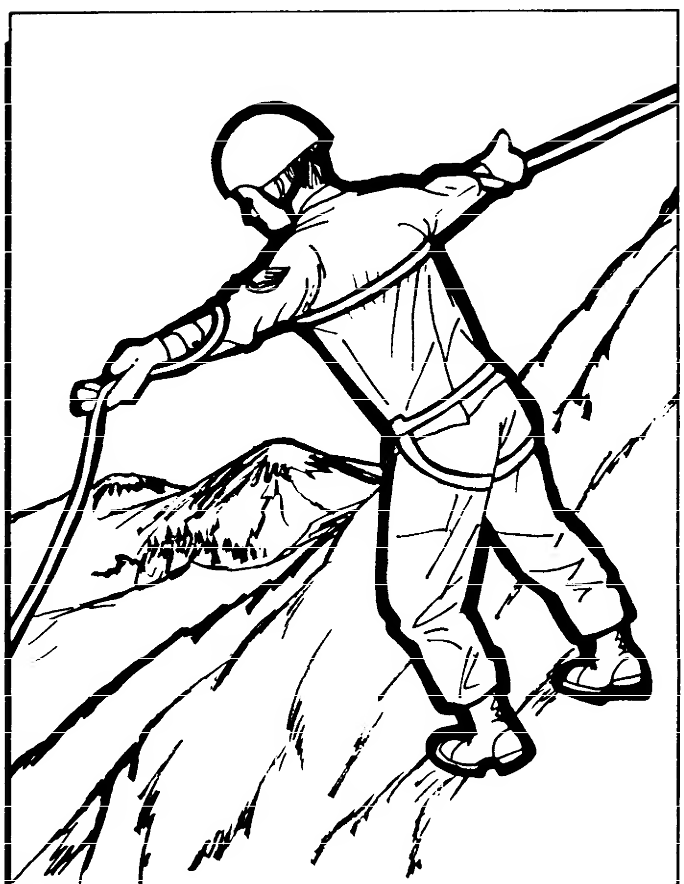


Figure 22-50. Hasty Rappel.

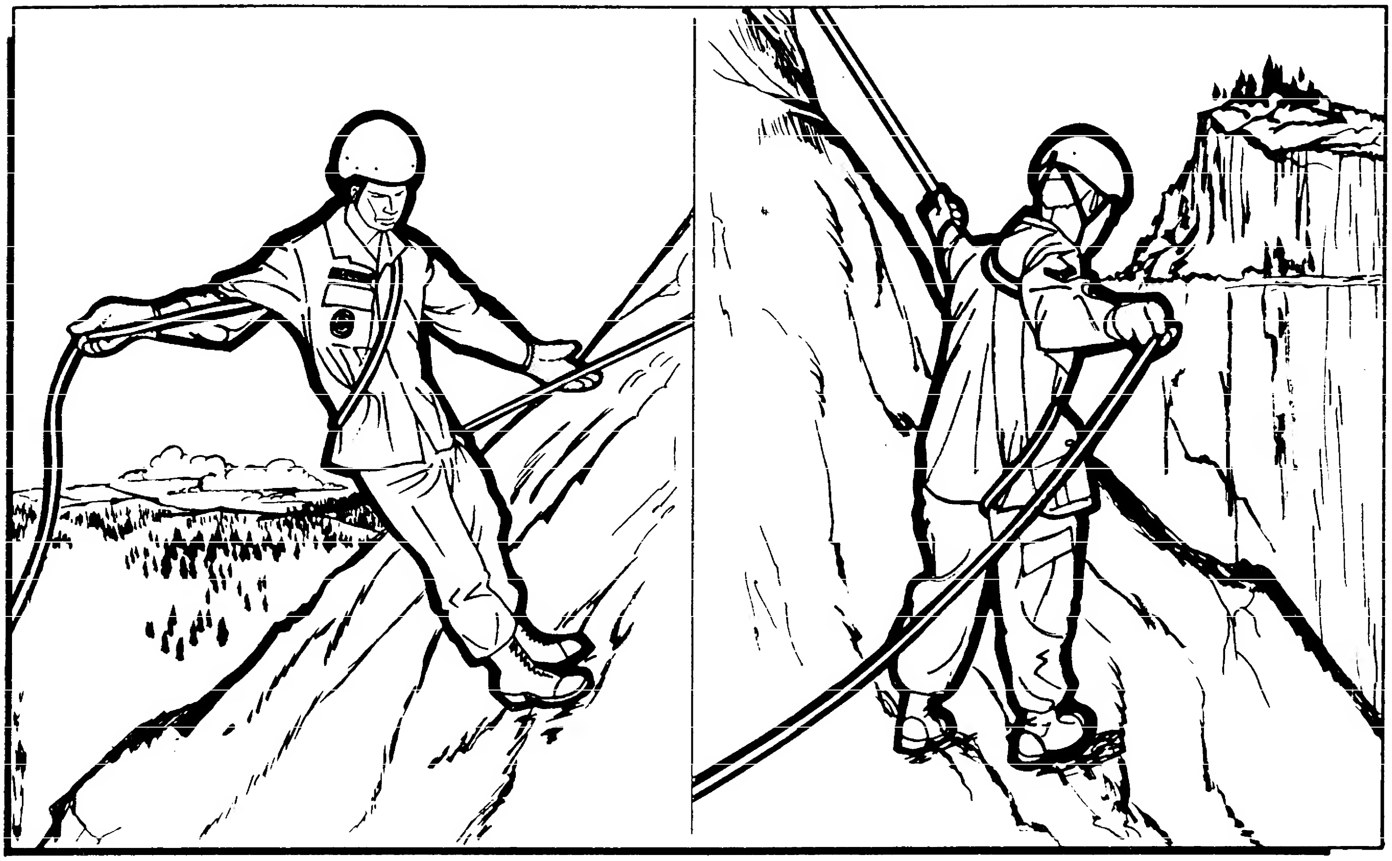


Figure 22-51. Body Rappel.

scend, hold the brake out to the side to reduce friction. To brake, cinch down on the rope and move the brake hand to the small of the back.

22-12. Overland Snow Travel. Cold-weather operations conducted in snow-covered regions magnify the difficulties of reaching a survivor and effecting an extraction. Routes of travel surveyed from the air may not be possible from the ground. A straight line from the insertion point to the objective is the most desired route; however, inherent dangers (avalanches, collapsing cornices, etc.) may necessitate an alternate route entailing a longer trek. During all operations, safety, and not ease of travel, will be the primary concern.

a. Snow Conditions. Travel time varies from hour to hour. Certain indicators may assist in the direction of travel; that is, the best snow condition is one which supports a person on or near the surface when wearing boots and the second best is calf-deep snow conditions. If possible avoid traveling in thigh- or waist-deep snow. Snowshoes should be worn when conditions dictate.

(1) South and west slopes offer hard surfaces late in the day after exposure to the Sun and the surface is refrozen. East and north slopes tend to remain soft and unstable. Walking on one side of a ridge, gully, clump of

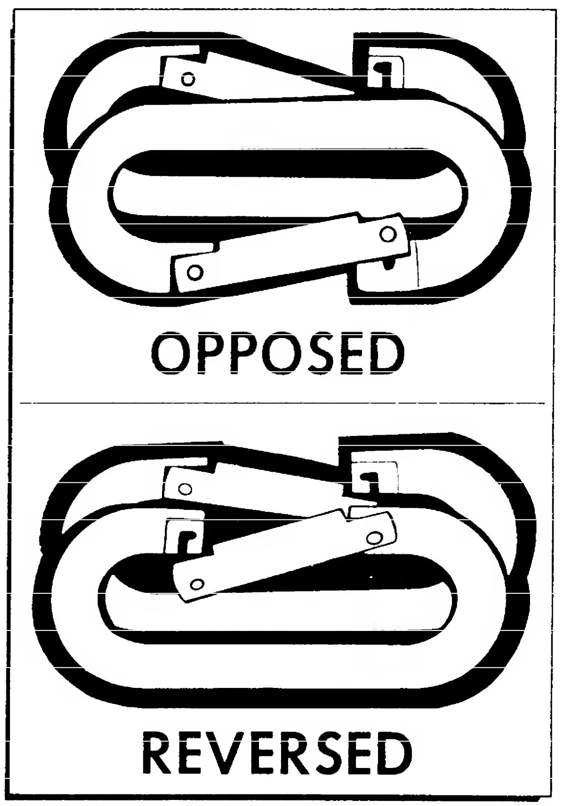


Figure 22-52. Seat Rappel (Carabiners).

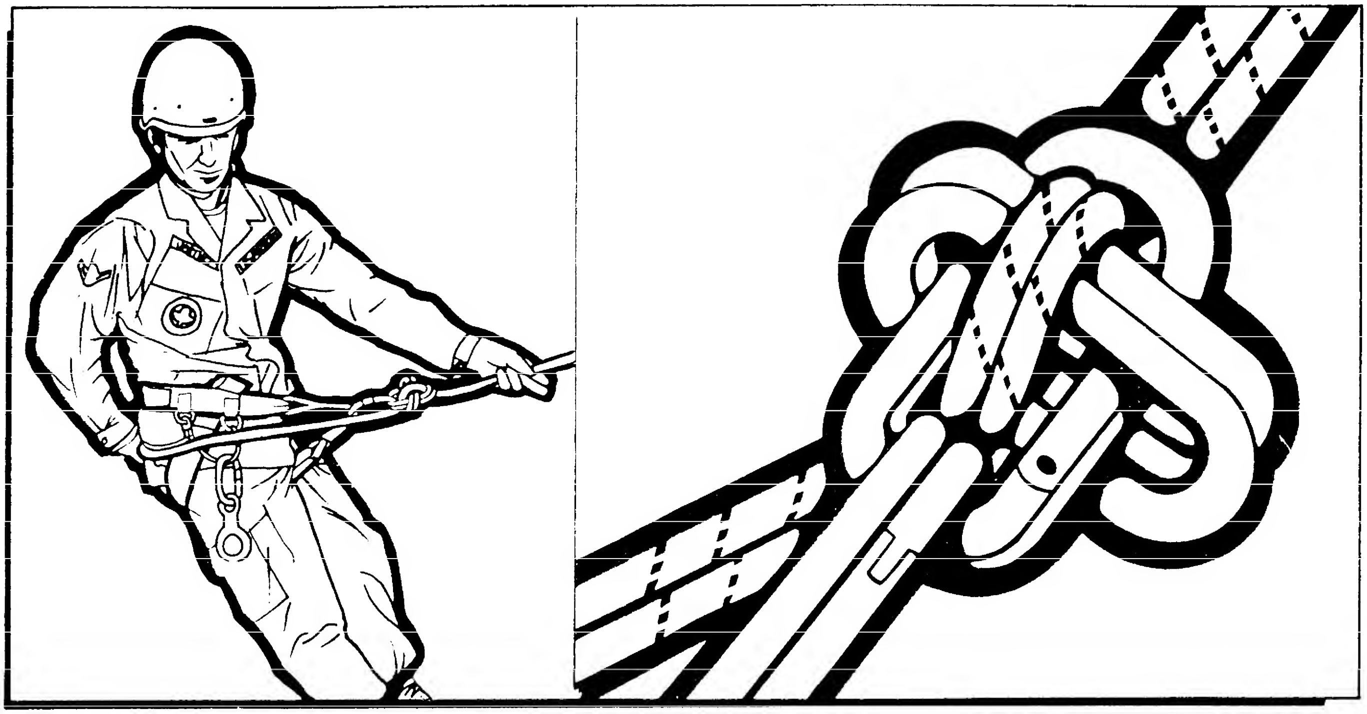


Figure 22-53. Four-Carabiner Brake System.

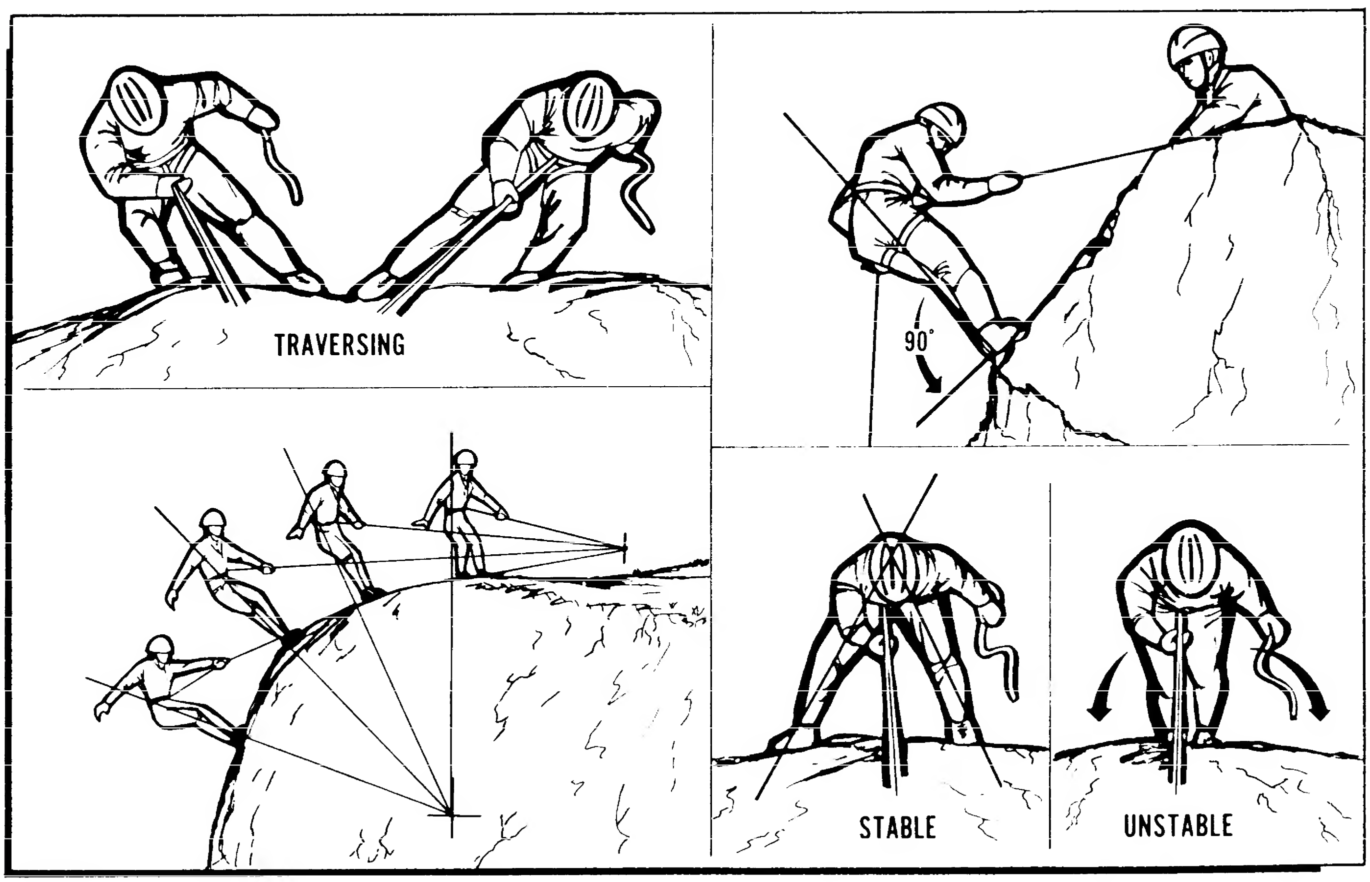


Figure 22-54. Body Position for Rappel.

trees, or large boulders is often more solid than the other side. Dirty snow absorbs more heat than clean snow; slopes darkened by rocks, dust, or uprooted vegetation usually provide more solid footing. Travel should be done in the early morning after a cold night to take advantage of stable snow conditions. Since sunlight affects the stability of snow, travel should be concentrated in shaded areas where footing should remain stable.

(2) In areas covered by early seasonal snowfall, travel between deep snow, and clear ground must be done cautiously. Snow on slopes tends to slip away from rocks on the downhill side, forming openings. These openings, called moats, are filled by subsequent snowfalls. During the snow season, moats below large rocks or cliffs may become extremely wide and deep, presenting a hazard to the rescue team.

b. Travel Speed. An over-zealous drive to reach an objective may be too fast for the endurance of the team. Fast starts at the point of insertion usually result in frequent stops for recuperation. The best way to reach an objective is to start with a steady pace and continue that pace throughout. Movement at reasonable speeds, with rest stops as required, will help prevent team "burnout." The following considerations further ensure steady advancement with minimal degradation to the team. A steady pace helps maintain an even rate of breathing. After the initial period of travel; that is, one-half hour, a shakedown rest should be initiated to adjust boots, snowshoes, crampons, packs, etc., or to remove or add layers of clothing.

c. Snowshoe Technique. A striding technique is used for movement with snowshoes. In taking a stride, the toe of the snowshoe is lifted upward to clear the snow and thrust forward. Energy is conserved by lifting the snowshoe no higher than is necessary to clear the snow. If the front of the snowshoe catches, the foot is pulled back to free it and then lifted before proceeding with the stride. The best and least exertive method of travel is a loose-kneed rocking gait in a normal rhythmic stride. Care should be taken not to step on or catch the other snowshoe.

(1) On gentle slopes, ascent is made by climbing straight upward. (Traction is generally very poor on hard-packed or crusty snow.) Steeper terrain is ascended by traversing and packing a trail similar to a shelf. When climbing, the snowshoe is placed horizontally in the snow. On hard snow, the snowshoe is placed flat on the surface with the toe of the upper one diagonally uphill to get more traction. If the snow will support the weight of a person, it is better to remove the snowshoes and temporarily proceed on foot. In turning, the best method is to swing the leg up and turn the snowshoe in the new direction of travel.

(2) Obstacles such as logs, tree stumps, ditches, and small streams should be stepped over. Care must be taken not to place too much strain on the snowshoe ends by bridging a gap, since the frame may break. In shallow snow, there is danger of catching and tearing the webbing on tree stumps or snags. Wet snow will frequently ball up under the feet, making walking uncomfortable. This snow should be knocked off with a stick or pole.

(3) Generally, ski poles are not used in snowshoeing; however, one or two poles are desirable when carrying heavy loads, especially in mountainous terrain. The bindings must not be fastened too tightly or circulation will be impaired and frostbite can occur. During stops, bindings should be checked for fit and possible readjustment.

d. Uphill Travel. Maximum altitude may be obtained with less effort by traversing a slope. A zigzag or switchback route used to traverse steep slopes places body weight over the entire foot as opposed to the balls of the feet as in a straight line uphill climb. An additional advantage to zigzagging or switchbacking is alternating the stress and strain placed on the feet, ankles, legs, and arms when a change in direction is made.

(1) When a change in direction is made, the body is temporarily out of balance. The proper method for turning on the steep slope is to pivot on the outside foot (the one away from the slope). With the upper slope on the right side, the left foot (pivot foot) is kicked directly into the slope. The body weight is transferred onto the left foot while pivoting toward the slope. The slope is then positioned on the left side and the right foot is on the outside.

(2) In soft snow on steep slopes, pit steps must be stamped in for solid footing. On hard snow, the surface is solid but slippery, and level pit steps must be made. In both cases, the steps are made by swinging the entire leg in toward the slope, not by merely pushing the boot into the snow. In hard snow, when one or two blows do not suffice, crampons should be used. Space steps evenly and close together to facilitate ease of travel and balance. Additionally, the lead climber must consider the other team members, especially those who have a shorter stride.

(3) The team should travel in single file when ascending, permitting the leader to establish the route. The physical exertion of the climbing leader is greater than that of any other team member. The climbing leader must remain alert to safeguard other team members while choosing the best route of travel. The lead function should be changed frequently to prevent exhaustion of any one individual. Team members following the leader should use the same leg swing technique to establish foot positions, improving each step as they climb. Each foot must be firmly kicked into place, securely positioning the boot in the step. In compact

snow, the kick should be somewhat low, shaving off snow during each step, thus enlarging the hole by deepening. In very soft snow, it is usually easier to bring the boot down from above, dragging a layer of snow into the step to strengthen and decrease the depth of it.

(4) When it is necessary to traverse a slope without an increase in elevation, the heels rather than the toes form the step. During the stride, the climber twists the leading leg so that the boot heel strikes the slope first, carrying most of the weight into the step. The toe is pointed up and out. Similar to the plunge step, the heel makes the platform secure by compacting the snow more effectively than the toe.

e. Descending. The route down a slope may be different from the route up a slope. Route variations may be required for descending different sides of a mountain or moving just a few feet from icy shadows onto sun-softened slopes. A good surface snow condition is ideal for descending rapidly since it yields comfortably underfoot. The primary techniques for descending snow-covered slopes are plunge stepping and descending step by step.

(1) The plunge step makes extensive use of the heels of the feet (figure 22-55) and is applicable on scree as well as snow. Ideally, the plunging route should be at an angle, one that is within the capabilities of the team and affords a safe descent. The angle at which the heel should enter the surface varies with the surface hardness. On soft snow slopes, almost any angle suffices; however, if the person leans too far forward, there is a risk of lodging the foot in a rut and inflicting injuries.

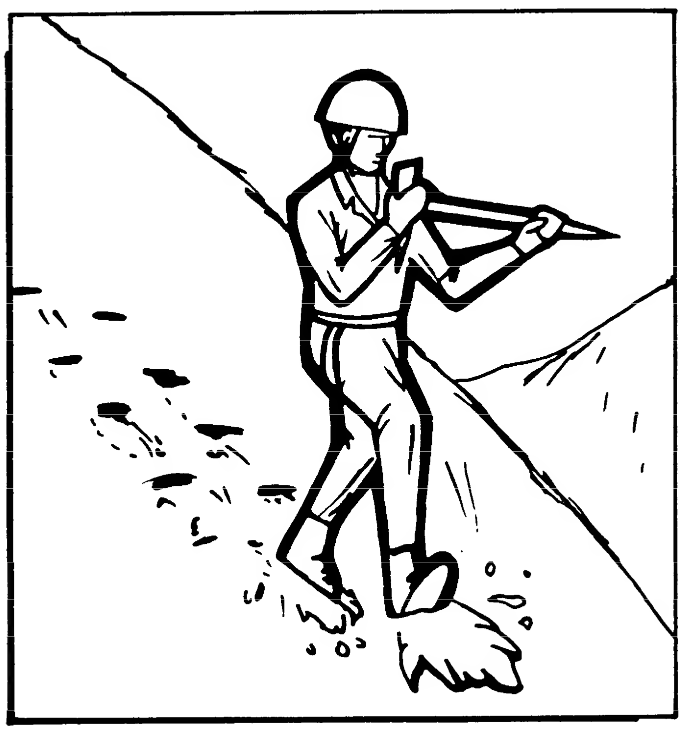


Figure 22-55. Plunge Step.

On hard snow, the heel will not penetrate the surface unless it has sufficient force behind it. Failure to firmly drive the heel into the snow can cause a slip and subsequent slide. The quickest way to check a slip is to shift the weight onto the other heel, making several short, stiff-legged stomps. This technique is not intended to replace "the ice arrest" technique which is usually more effective. When roped, plunging requires coordination and awareness of all team members' progress. Speed of the team must be limited to the slowest member. Plunging is unsatisfactory when wearing crampons due to the snow compacting and sticking to them.

(2) The technique of step-by-step descending is used when the terrain is extremely steep, snow significantly deep, or circumstances dictate a slower pace. On near-vertical walls, it is necessary to face the slope and cautiously lower oneself step by step, thrusting the toe of the boot into the snow while maintaining an anchor or handhold with the axe. Once the new foothold withstands the body's full weight, the technique is repeated. On moderately angled terrain, the team can face away from the slope and descend by step-kicking with the heels.

22-13. Snow and Ice Climbing Procedures and Techniques. Snow and ice climbing differs from rock climbing, yet many of the procedures and techniques are the same. Belay tie-in commands, principles of runner placement, straight-line climbing, and placement of protection are common to snow and ice as well as rock. As expected, however, there are major differences from rock climbing.

a. Ice Axe Techniques (figure 22-56). The axe is the most important tool a climber carries. It can be used for braking assistance when a climber begins sliding down a steep snow-covered incline.

(1) Each rescuer (climber) must practice the self-arrest technique before venturing onto steep grades. Since the ice axe arrest requires the use of the ice axe, the climber must hang onto it at all times. The ice axe, whether sharp or not, is a lethal weapon when flying about on the attached cord. Physically, the climber rigs

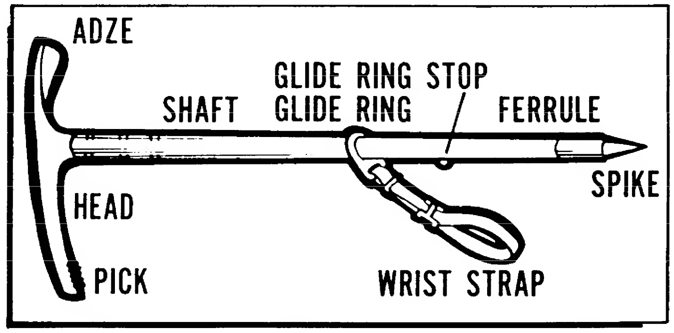


Figure 22-56. Ice Axe.

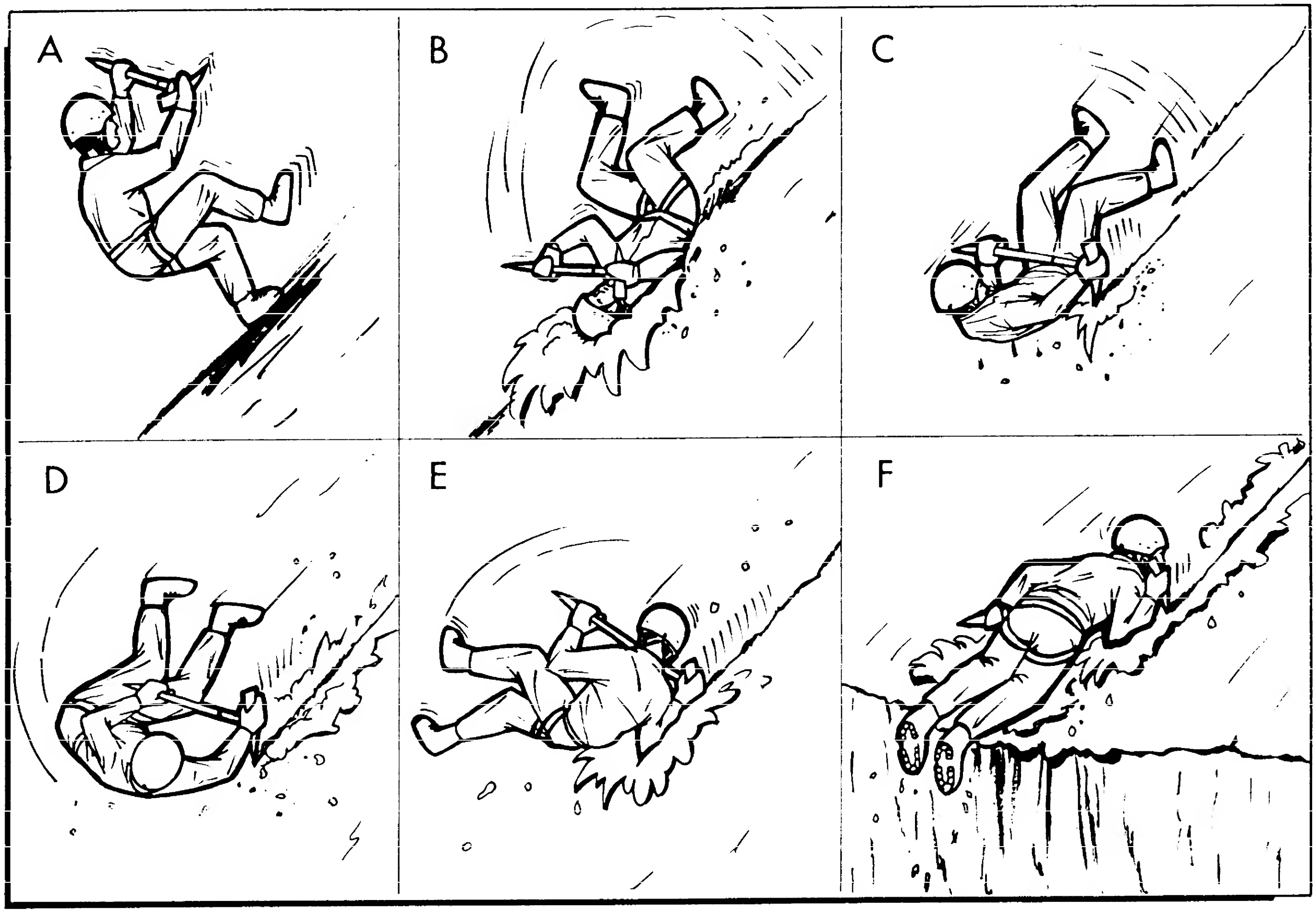


Figure 22-57. Ice Axe Self-Arrest.

for arrest by rolling down shirt sleeves, putting on mittens, securing loose gear, and most important of all, making certain the axe is held correctly. Mentally prepare by recognizing the importance of instantaneous application. A quick arrest, before the fall picks up speed, has a better chance of success than a slow arrest. Preparation for an ice axe arrest should be taken when traveling on terrain which could result in a fall.

(2) The proper method of holding an ice axe for self-arrest (see figure 22-57) is to place one hand on the head of the axe with the thumb under the adze and fingers over the pick. The other hand is placed on the shaft next to the spike. The pick is pressed into the slope just above the shoulder so the adze is near the angle formed by the neck and shoulders. The shaft should cross the chest diagonally with the spike held firmly close to the opposite hip. A short axe is held in the same position, although the spike will not reach the opposite hip. Chest and shoulders should press strongly on the shaft and the spine should be arched slightly to distribute weight primarily at the shoulders and toes. The legs should be stiff and spread apart, toes digging in (if wearing crampons, keep the toes off the surface until almost stopped), and hang on to the axe!

b. Team Arrest. The team arrest is intermediate between self-arrest and belays. When there is doubt that a person could arrest a fall, such as on crevassed glaciers and steep snowfields, and conditions are not so extreme as to make belaying necessary, the party ropes up and travels in unison. If any member falls, arrest is made by two or three axes. The rope between the climbers must be fully extended except for minimum slack carried by the second and subsequent persons to allow them to flip the rope out of the track (steps). This also allows easy compensation for pace variations. However, slack is minimized to bring the second and subsequent axes into action at the moment of need. A roped climber who falls should immediately yell "FALLING." It is not advisable to delay the alarm to see how "self-arrest" will develop because team members may hear the signal after they have been pulled into their own falls, decreasing their ability to help. When roped climber(s) hear the cry "falling," they immediately drop into self-arrest position.

c. Boot Axe Belay (figure 22-58). The boot axe belay can be set up rapidly and used when a team is moving together and belaying is only required at a few spots. The boot axe belay should be practiced until a sweep

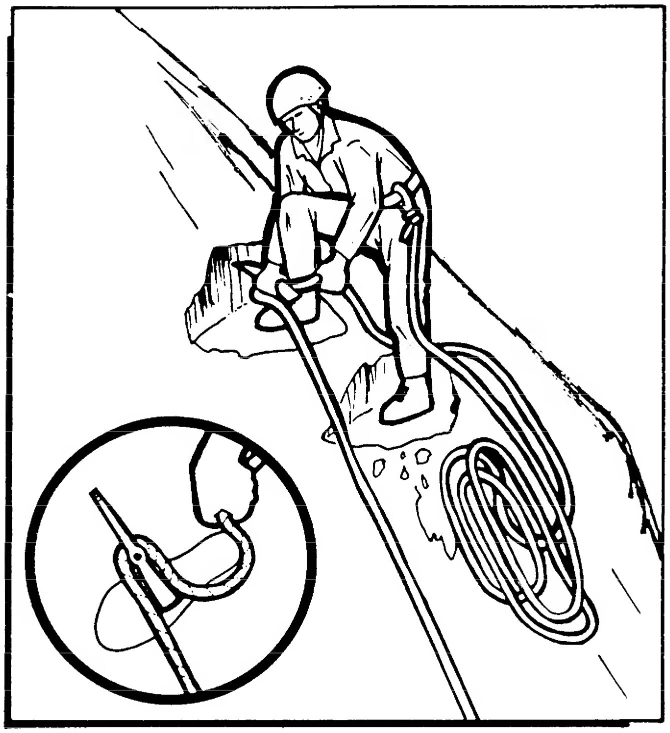


Figure 22-58. Boot Axe Belay.

and jab of the ice axe can set up the stance within a couple of seconds. The axe provides an anchor to the slope and the slope and the boot braces the axe. Both give a friction surface over which the run of rope is controlled.

(1) To prepare a boot axe belay, a firm platform, large enough for the axe and uphill boot, is stamped out in the snow. The ice axe shaft is jammed as deeply as possible, at a slight uphill angle (against the anticipated fall) into the snow at the rear of the platform. The pick is parallel to the fall line, pointing uphill, thus applying the strongest dimension of the shaft against the force of a fall. The length of the pick prevents the rope from escaping over the top of the shaft.

(2) The belayer stands below the axe, facing at a right angle to the fall line. The uphill boot is stamped into the slope against the downhill side of the shaft at a right angle to the fall line, bracing the shaft against downhill pull. The downhill boot is in a firmly compacted step below the uphill boot so that the leg is straight, stiffly bracing the belayer. The uphill hand is on the axe head in arrest grasp, bracing the shaft against downhill and lateral stress. From below, the rope crosses the toe of the boot, preventing the rope from trenching into the snow. The rope bends around the uphill side of the shaft, then down across the instep of the bracing boot, and is controlled by the downhill hand. To apply braking through greater friction, the downhill or braking hand brings the rope uphill around the heel, forming an "S" bend.

d. Crampon Techniques:

(1) Donning. When attaching the harness, the buckles should be positioned to cinch on the outward sides of the boots. Special care must be taken to strap the crampons tightly to the boots, running the strap through each attachment prong or ring. If crampons do not have heel loops, ankle straps should be long enough to be crossed behind the boot before being secured to prevent boots from sliding backward out of the crampons. Many crampons have been lost because this precaution was not taken. When trimming new straps, allowance must be made for gaiters which sometimes cover the instep of the boot. Donning is best done by laying each crampon on the snow or ice with all rings and straps outward; then place the boot on the crampon and tighten the straps. Even modern neoprene-coated nylon straps should be checked from time to time to make sure they are tight, have not been cut, and are not trailing loop strap ends which could cause the wearer to trip.

(a) If it is believed crampons may be needed, they must be carried. Conditions change rapidly; an east-facing slope may be mushy enough for step-kicking during the morning, but can become a sheet of smooth white ice in the afternoon shade. Furthermore, cramponing may contribute directly to the team's safety by enabling it to negotiate stretches of ice faster and with less fatigue than having to chop steps. The decision of whether or not to wear crampons is determined by the situation. Wearing crampons should not be considered mandatory because of venturing onto a glacier; neither should a team attempt to save time by never wearing crampons on steep, exposed icy patches just because they are fairly short. Another important guideline is to don crampons before they are needed to avoid donning them while teetering in ice steps. On mixed rock and ice climbs, constant donning and removing of crampons takes so much time that the objective may be lost.

(b) Crampons should be worn throughout the entire climb if the terrain is 50 percent or more suitable for crampons (crampons may skid or be broken on rock surfaces). Crampons are not required if the snow or ice patches are fairly short, good belays are available, and rock predominates. These alternatives are suggestions and the team leader's decision must be based on the conditions at hand.

(c) Crampons should be taken off when the snow begins to ball up badly in them and no improvement in snow conditions is anticipated. On the ascent, it may be possible to clear away the soft surface snow and climb on the ice below, but this is usually impractical and futile on the descent. Occasionally the climber should kick the crampons free of accumulated snow. The time-worn practice of striking the ice axe shaft against the crampons to knock out the snow is effective, but hard on the axe and perhaps the ankle. In situations where the crampons must be worn even though the snow balls

up in them, shuffling the feet through the snow instead of stepping over the surface tends to force the accumulated snow through the back points. The normal kicking motion of the foot generally keeps the crampons snow-free on the ascent and while traversing.

(d) On the descent, drive the toe of the boot under the surface of the snow ahead of the heel, walking on the ball of the foot. Keep the weight well forward and use short skating steps allowing the foot to slide forward and penetrate the harder sublayers.

(2) Flatfooting. Flatfooting involves a logical and natural progression of coordinated body and ice axe positions to allow the climber to move steadily and in balance while keeping all vertical points of the crampons biting into the ice. The weight is carried directly over the feet, the crampon points stamped firmly into the ice with each step, with the ankles and knees flexed to allow boot soles to remain parallel to the slope.

(a) On gentle slopes, the climber walks straight up the hill. Normally, the feet are naturally flat to the slope and the axe is used as a cane. If pointing the toes uphill becomes awkward, they may be turned outward in duck-fashion. As the slope steepens, the body is turned to face across the slope rather than up it. The feet may also point across the slope, but additional flexibility and greater security are gained by pointing the lower foot downhill. The axe is used only to maintain balance and may be carried in the cane position or the arrest grasp with either the pick or point touching the slope. (Movement is diagonal rather than straight upward and the climber takes advantage of terrain irregularities and graded slopes. Changes in direction are done as in step-kicking on snow by planting the downhill foot, turning the body toward the slope to face the opposite direction, and stepping off with the new downhill foot.)

(b) On gentler slopes, the flat-footed approach is used throughout, but it is more secure and easier on steeper slopes to initiate the turn by kicking the front points and briefly front-pointing through the turn. At some point in the turn, the grip on the axe must be reversed. The exact moment for this depends on the climber and the specific situation. However, the climber's stance must be secure when the third point of support—the axe is temporarily relinquished.

(c) On steep slopes, which approach the limit of practical use of this style of ascent, the climber relies on the axe for security of a hold as well as for balance. The axe is held in the arrest grasp with one hand on the head and the other on the shaft, above the point. The well-sharpened pick is planted firmly in the ice at about shoulder height to provide one point of suspension while a foot moves forward and the crampons are stamped in (figure 22-59).

(d) Descent follows the same general progression of foot and axe positions; descend the fall line, gradually turning the toes out as the slope gets steeper. As the slope steepens, widen the stance, flex the knees, and lean forward to keep weight over the feet, and finally, face sideways and descend with the support of the axe in the arrest position. On very steep or hard ice, it may be necessary to face the slope and front-point downwards. When flat-footing downhill, all crampon points should be stamped firmly into the ice. It may be necessary to strive to take small steps which allow the climber to maintain balance during moves; long steps require major weight shifts to adjust balance.

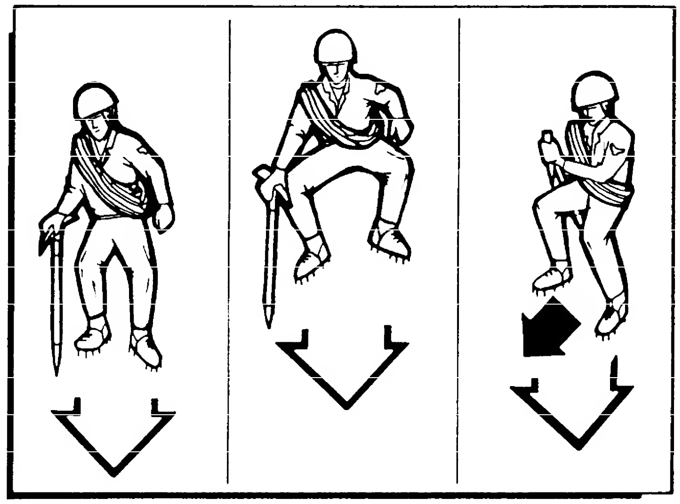


Figure 22-59. Descent with Crampons.

e. Anchors. Snow and ice conditions require the use of special devices for establishing belay anchors or placement of intermediate protection during a climb.

(1) Snow Pickets. Three- to four-foot lengths of aluminum "T" or tubular sections perform as long pitons and are suited for belaying. They must always be used in pairs or greater numbers, one anchoring the other (figure 22-60).

(2) Snow Fluke. A 12-inch piece of metal is buried with a runner coming to the surface; this can pull out if snow conditions are not just right. Better resistance to pull-out is gained with a large flat piece of metal driven into the snow surface at an angle, acting in the same manner as the fluke of an old-fashioned anchor. There is no danger of the runner being cut or weakened from wet conditions with the attachment of a wire cable. The softer the snow, the larger the size of the plate. When using flukes, it is very important that the proper angle with the surface be maintained; otherwise, wire, instead of becoming stronger (going deeper) when pulled, will become weaker (surface). Additionally, the cable may

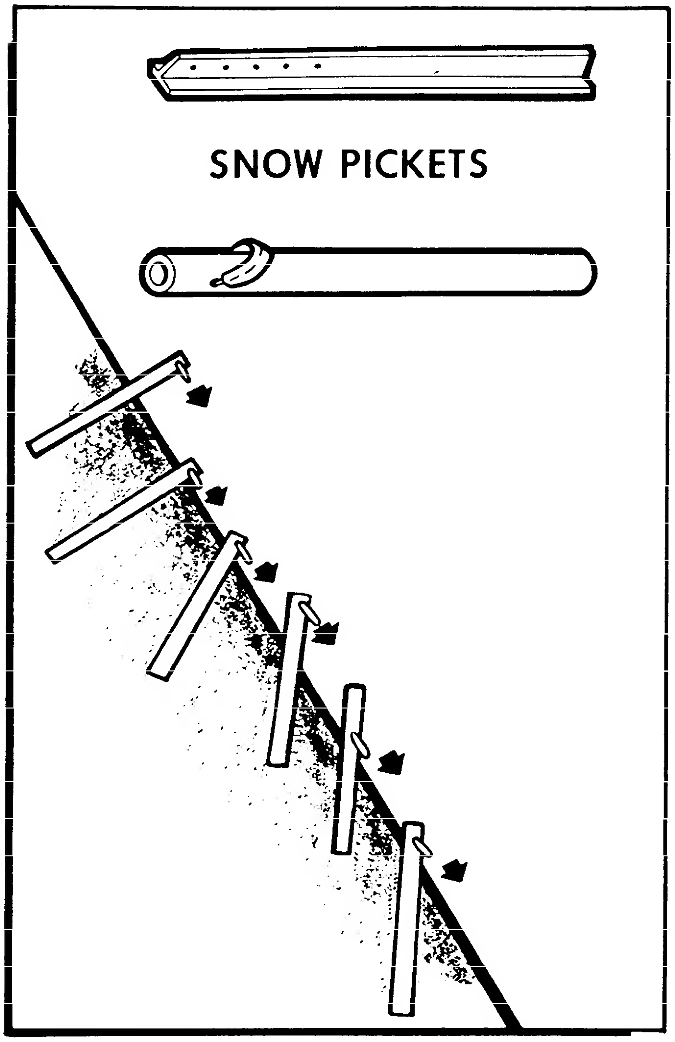


Figure 22-60. Snow Pickets.

act as a lever arm on hard snow, causing the fluke to pop out. This can be prevented by carefully cutting a channel in the snow for cables so that the pull comes directly at the plate. If attention is paid to placement, snow flukes will provide great security as belay and rappel anchors. A properly placed fluke is secure for a sitting or standing hop belay on snow (figure 22-61).

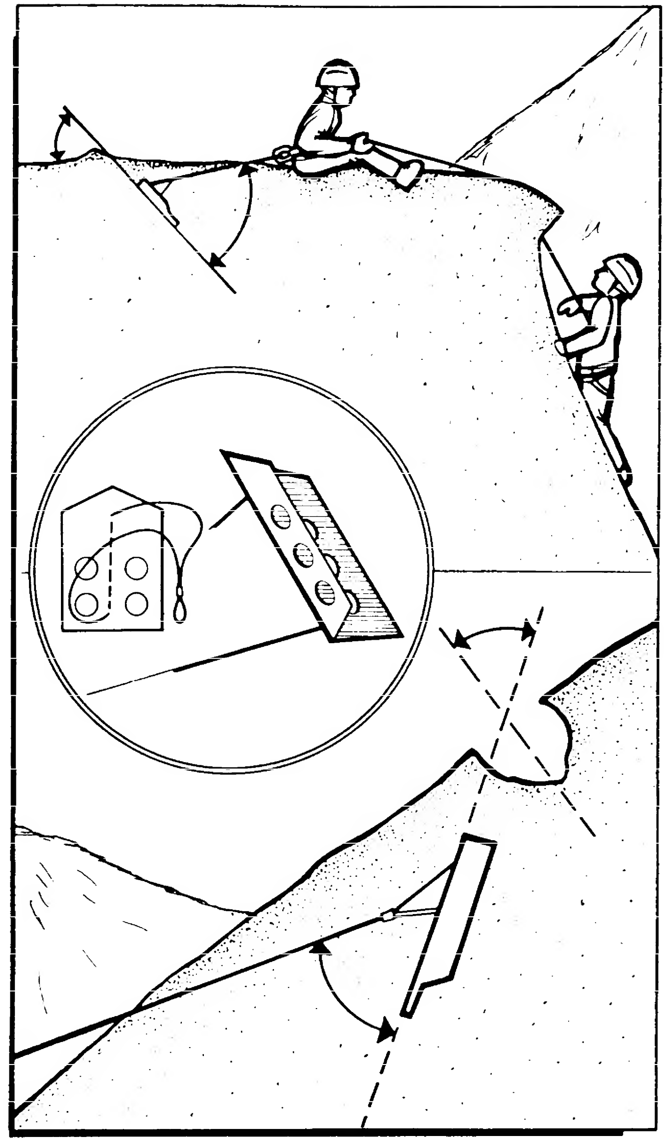


Figure 22-61. Snow Flukes.

(3) Ice Screws:

(a) Tubular screws are very strong and are the most reliable (figure 22-62). They are difficult to place in hard or water ice since they tend to clog and have a large cross section. Their main advantage is that they minimize "spalling" (a crater-like splintering of the ice around the shaft of the screw) by allowing the displaced ice to work itself out through the core of the screw. If the core of the ice remaining in the screw is frozen in place, it jams the screw in subsequent placements. The ice may be removed by pushing with a length of wire or by heating with a cigarette lighter. This type of screw requires both hands for placement; however, once it is started, the pick of an ice hammer or axe inserted in the eye allows the climber to gain the advantage of leverage. Removal is easy and melt-out is slow due to the large cross section.

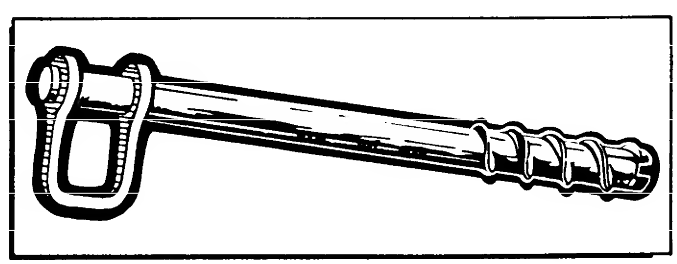


Figure 22-62. Tubular Ice Screw.

(b) Heavier "coathanger" type screws can be relied upon to stop a fall (figure 22-63). They are easier to start in hard ice than tubular screws and can often be placed with one hand, although it may be necessary to tap them while twisting as they are started. Their holding power is less than tubular screws as they tend to fracture hard ice and, under heavy loads, tend to shear through the ice because of their small cross section.

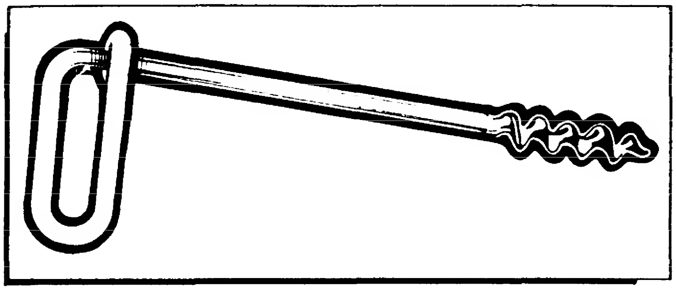


Figure 22-63. Coathanger Ice Screw.

(c) Developed as an attempt to make an easy-to-place and easy-to-remove screw, the solid screws are driven in like a piton and screwed out (figure 22-64). They offer excellent protection in water ice but are less effective in other ice forms. Melt-out is sometimes rapid because of limited thread displacement and, under load, they tend to shear through the ice as do coathanger screws.

(d) Before placement of ice screws or pitons, any soft snow or loose ice should be scraped or chopped away until a hard and trustworthy surface is reached. A small starting hole punched out with the pick or spike of the axe or hammer facilitates a good grip for the starting threads or teeth. The screw is pressed firmly into the ice and twisted in at the same time, angled slightly uphill against the anticipated direction of pull. Ice pitons are, of course, driven straight in, but must also be angled against the pull that would result from a fall (figure 22-65). If any spalling or splintering of the ice occurs, the screw should be removed and another placement tried 1 or 2 feet away. Some glacier ice will spall near the surface but by continuing to place the screw and gently chopping out the shattered ice, a deep, safe placement may be obtained. As a general rule, short screws or pitons should be used in hard ice and long ones in softer ice. They should always be placed in the ice until the eye is flush with the surface. When removing ice hardware, take care not to bend it since this diminishes its effectiveness in future use.

(4) Ice/Snow Bollard. Although not a natural anchor in itself, an ice or snow bollard is easily made from natural materials. A semicircular trench is dug in the snow or ice. The trench should be 3 to 4 feet across and 6 to 12 inches deep. Allow a larger size for poor

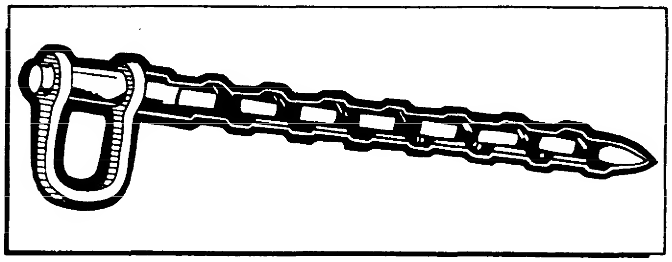


Figure 22-64. Solid Ice Screw.

snow or ice conditions. The rope can be positioned in the trench to provide a downward belay (figure 22-66).

f. Glissading. Glissading is a means of rapidly descending a slope. Consisting of two basic positions, glissading offers a speedy means of travel with less energy exerted than using the descending step-by-step or plunging techniques.

(1) When snow conditions permit, the sitting glissade position is the easiest way to descend. The climber simply sits in the snow and slides down the slope while holding the axe in an arrest position (figure 22-67). Any tendency of the body to pivot head downwards may be checked by running the spike of the axe rudder-like along the surface of the snow. Speed is increased by lying on the back to spread the body weight over a greater area and by lifting the feet in the air. Sitting back up and returning the feet to the snow surface reduces speed. On crusted or firmly consolidated snow, sit fairly erect with the heels drawn up against the buttocks and the boot soles skimming along the surface. Turns are nearly impossible in a sitting glissade; however, the spike, dragged as a rudder and assisted by body contortions, can effect a change in direction of several degrees. Obstructions on the slope are best avoided by rising into a standing glissade (figure 22-67) for the turn, and then returning to the sitting position. Speed is decreased by dragging the spike and increasing pressure on it. After the momentum has been checked by the spike, the heels are dug in for the final halt but not while sliding at a fast rate as the result is likely to be a somersault. Emergency stops at high speeds are made by arresting.

(2) The standing glissade is similar to skiing. Positioned in a semicrouch stance with the knees bent as if sitting in a chair (figure 22-67), the legs are spread laterally for stability, and one foot is advanced slightly to anticipate bumps and ruts. For additional stability, the spike of the axe can be skimmed along the surface, the shaft held alongside the knee in the arrest grasp, with the pick pointing down or to the outside away from the body. Stability is increased by widening the spread of

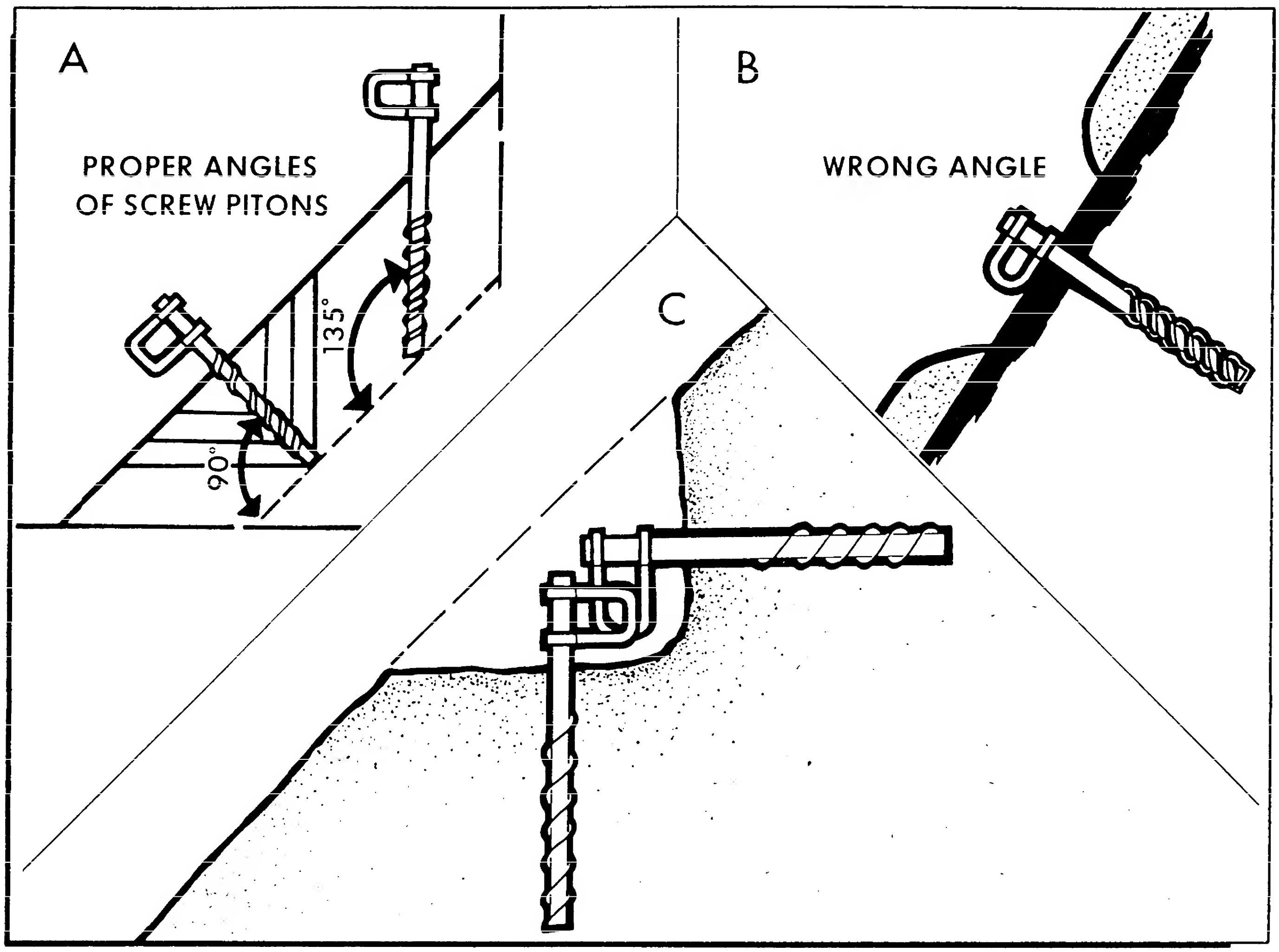


Figure 22-65. Placement of Ice Screw and Piton.

the legs, deepening the crouch, and putting more weight on the spike. A decrease in speed increases muscular strain and the technique becomes awkward and trying, although safe. Speed is increased by bringing the feet close together, reducing weight on the spike, and leaning forward until the boot soles are running flat along the surface like short skis. If the slide is too shallow, a long skating stride helps.

(3) A glissade should be made only when there is a safe runout. Unless a view of the entire run can be obtained beforehand, the first person down the run must use extreme caution, stopping frequently to study the terrain ahead. Equipment must be adjusted before beginning the descent. Crampons and other hardware must be properly stowed. Never attempt to glissade while wearing crampons as it is extremely easy to snag a crampon and be thrown down the slope. Mittens or gloves are worn to protect the hands and to maintain control of the axe. Heavy waterproof pants provide protection to the buttocks. Gaiters are also helpful for all glissading. Glissades should never be attempted in terrain where the axe safety cord is required. The hazards

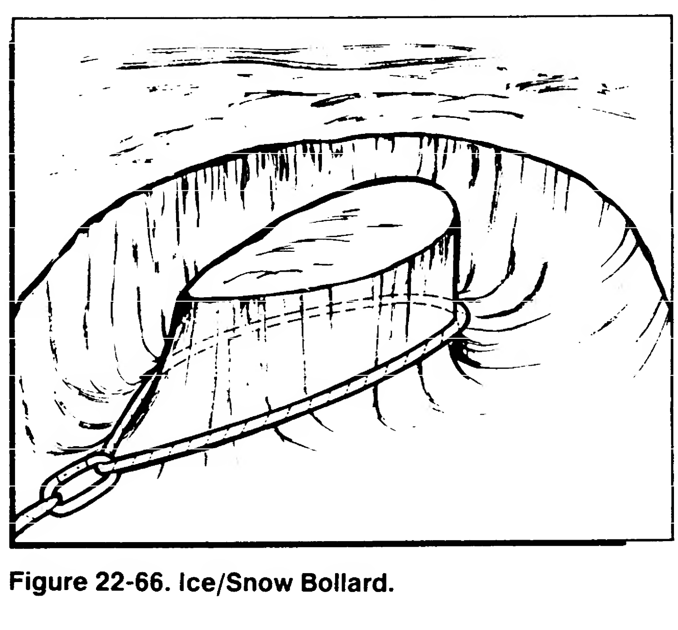


Figure 22-66. Ice/Snow Bollard.

Figure 22-67. Glissading.

of a flailing ice axe should never be risked during a glissade.

22-14. Glaciers and Glacial Travel:

a. Features. To cope with the problems which can arise in using glaciers as avenues of travel, it is important to understand something of the nature and composition of glaciers.

(1) A valley glacier is essentially a river of ice and it flows at a rate of speed that depends largely on its mass and the slope of its bed. A glacier consists of two parts:

(a) The lower glacier, which has an ice surface void of snow during the summer.

(b) The upper glacier, where the ice is covered, even in summer with layers of accumulated snow that changes into glacier ice.

(2) To these two integral parts of a glacier may be added two others which, although not a part of the glacier proper, are generally adjacent to it and are of similar composition. These adjacent features, the ice and snow slopes, are immobile since they are anchored to underlying rock slopes. A large crevasse separates such slopes from the glacier proper and defines the boundary between moving and anchored ice.

(3) Ice is plastic-like near the surface, but not smooth enough to prevent cracking as the ice moves forward over irregularities in its bed. Fractures in a glacier surface, called crevasses, vary in width and depth from only a few inches to many feet. Crevasses form at right angles to the direction of greatest tension and due to a limited area, tension is usually in the same direction. Crevasses in any given area tend to be roughly parallel to each other. Generally, crevasses develop across a slope. Therefore, when traveling up the middle of a glacier, people usually encounter only transverse crevasses (crossing at right angles to the main direction of the glacier). Near the margins or edges of a glacier, the ice moves more slowly than it does in midstream. This speed differential causes the formation of crevasses diagonally upstream away from the margins or sides. While crevasses are almost certain to be encountered along the margins of a glacier and in areas where a steepening in gradient occurs, the gentlest slopes may also contain crevasses.

(4) An icefall forms where an abrupt steeping of slope occurs in the course of a glacier. These stresses are set up in many directions. As a result, the icefall consists of a varied mass of iceblocks and troughs with no well-defined trend to the many crevasses.

(5) As a glacier moves forward, debris from the valley slopes on either side is deposited on its surface. Shrinkage of the glacier from subsequent melting causes this debris to be deposited along the receding margins of the glacier. Such ridges are called lateral (side) moraines. Where two glaciers join and flow as a single river of ice, the debri on the adjoining lateral margins of the glaciers also unites and flows with the major ice stream, forming a medial (middle) moraine. (By examining the lower part of a glacier, it is often possible to tell how many tributaries have joined to form the lower trunk of the glacier.) Terminal (end) moraine is usually found where the frontage of the glacier has pushed forward as far as it can go; that is, to the point at which the rate of melting equals the speed of advance of the ice mass. This moraine may be formed of debri pushed forward by the advancing edge or it may be formed by a combination of this and other processes.

(a) Lateral and medial moraines may provide excellent avenues of travel. When the glacier is heavily crevassed, moraines may be the only practical routes. Ease of progress along moraines depends upon the stability of the debris composition. If the material consists of small rocks, pebbles, and earth, the moraine is usually loose and unstable and the crest may break away at each footstep. If large blocks compose the moraine, they have probably settled into a compact mass and progress may be easy.

(b) On moraine travel, it is best either to proceed along the crest or, in the case of lateral moraines, to follow the trough which separates it from the mountainside. Since the slopes of moraines are usually unstable, there is a great risk of spraining an ankle on them. Medial moraines are usually less pronounced than lateral moraines because a large part of their material is transported within the ice. Travel on them is usually easy but should not be relied upon as routes for long distances since they may disappear beneath the glacier surface. Only rarely is it necessary for a party traveling along or across moraines to be roped together (figure 22-68).

(6) Glacial rivers are varied in type and present numerous problems to those who must cross or navigate them. Wherever mountains and highlands exist in the arctic regions, melting snows produce concentrations of water pouring downward in a series of falls and swift chutes. Rivers flowing from icecaps, hanging piedmonts (lake-like), or serpentine (winding or valley) glaciers are all notoriously treacherous. Northern glaciers may be vast in size and the heat of the summer sun can release vast quantities of water from them. Glacier ice is extremely unpredictable. An ice field may look innocent from above, but countless subglacial streams and water reservoirs may be under its smooth surface. These reservoirs are either draining or temporarily blocked. Mile-long lakes may lie under the upper snowfield, waiting only for a slight movement in the glacier to liberate them sending their waters into the valleys below. Because of variations in the amounts of water released by the Sun's heat, all glacial rivers fluctuate in water level. The peak of the flood water usually occurs in the afternoon as a result of the noonday heat of the Sun on the ice. For some time after the peak has passed, rivers which drain glaciers may not be fordable or even navigable. However, by midnight or the following morning, the water may recede so fording is both safe and easy. When following a glacial river broken up into many shifting channels, choose routes next to the bank rather than taking a chance on getting caught between two dangerous channels.

(7) Glaciers from which torrents of water descend are called flooding glaciers. Two basic causes of such glaciers are the violent release of water which the glacier carried on its surface as lakes, or the violent release of large lakes which have been dammed up in tributary glaciers because of the blocking of the tributary valley by the main glacier. This release is caused by a crevasse or a break in the moving glacial dam; the water then roars down in an all-enveloping flood. Flooding glaciers can be recognized from above by the flood-swept character of the lower valleys. The influence of such glaciers is sometimes felt for many miles below. Prospectors have lost their lives while rafting otherwise safe rivers because a sudden flood entered by a side tributary and descended as a wall of white, rushing water.

(8) On those portions of a glacier where melting occurs, runoff water cuts deep channels in the ice surface and forms surface streams. Many such channels exceed 20 feet in depth and width. They usually have smooth sides and undercut banks. Many of these streams terminate at the margins of the glacier where in summer they contribute to the torrent that constantly flows between the ice and the lateral moraine. Size increases greatly as the heat of the day moves to an end. The greatest caution must be taken in crossing a glacial surface stream since the bed and undercut banks are usually hard, smooth ice which offers no secure footing.

(9) Some streams disappear into crevasses or into round holes known as glacial mills, and then flow as subglacial streams. Glacial mills are cut into the ice by the churning action of water. They vary in diameter. Glacial mills differ from crevasses, not only in shape but also in origin, since they do not develop as a result of moving ice. In places, the depth of a glacial mill may equal the thickness of the glacier.

b. Glacier Operations. The principal dangers and obstacles to operations in glacier areas are crevasses and icefalls. Hidden crevasses present unique problems and situations since their presence is often difficult to detect. When one is detected, often it is due to a team member having fallen through the unstable surface cover. The following techniques and procedures should be followed when performing glacier operations.

(1) Equipment Preparation. The prevention of hypothermia should be of primary importance when performing glacier operations. Sufficient protective clothing must be worn or carried to cover all climatic temperature variations. Climbers trapped in crevasses have died of hypothermia while their team members, helpless to assist from their position on the glacier surface above, were sweltering in sunshine. Backpacks should be equipped with a lanyard consisting of a 6-foot piece of line with a figure-eight and nonlocking carabiner at one end. The free end of the lanyard is attached to the pack and the unlocking carabiner is snapped into the buttock strap of the seat harness. If the climber falls into a crevasse and is suspended upside down by the weight of the pack, the pack can be released with the lanyard and the person can return to an upright position.

(2) Team Composition. The first law of glacial travel is to rope-in during travel. The principal consideration is to avoid crevasses. When stepping onto a known glacier or onto a snowfield of unknown stability,

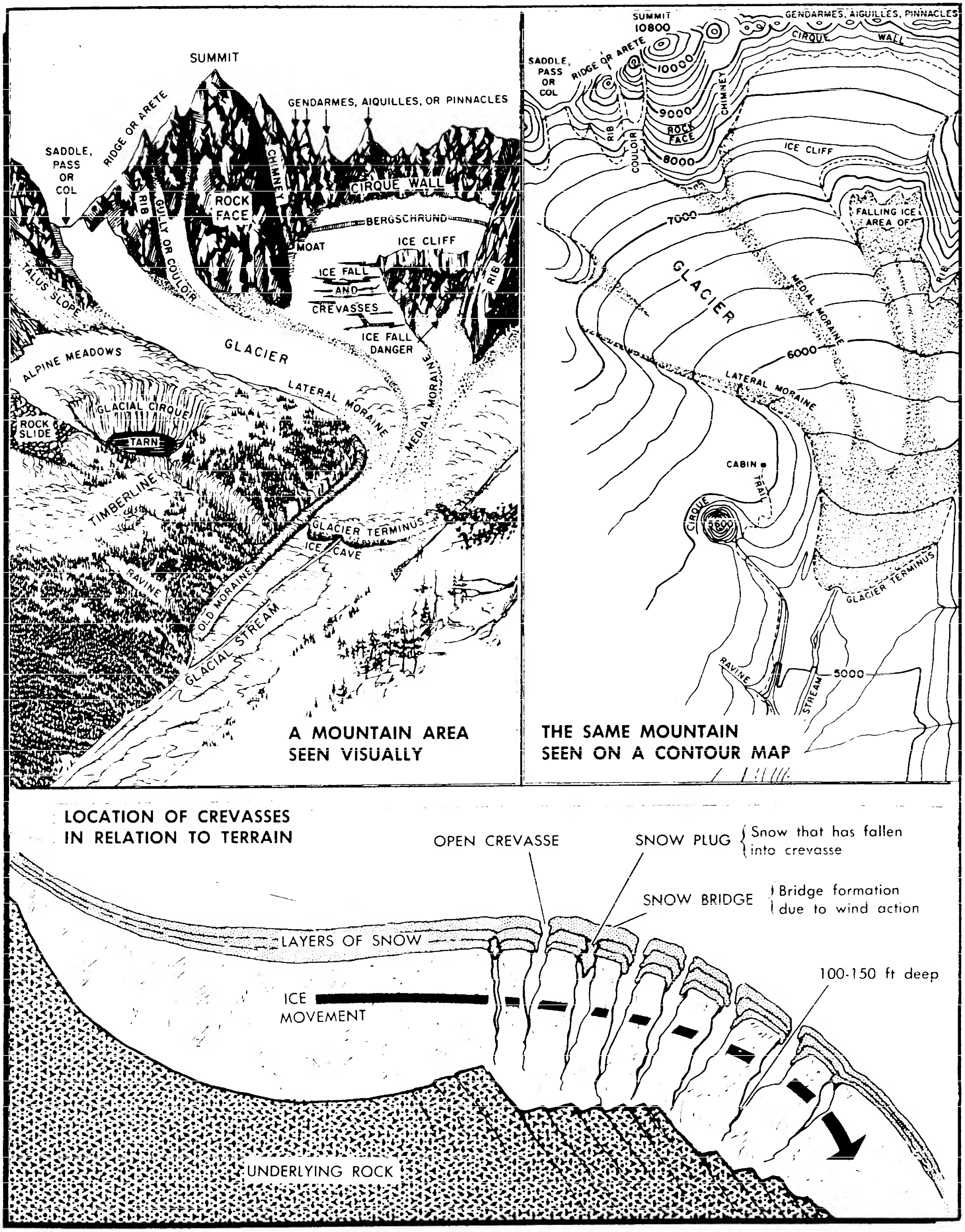


Figure 22-68. Typical Glacier Construction.

whether crevasses are visible or not, the law of roping-in remains. The only variable to this law is when avalanches present a greater hazard than the threat of crevasses. The most experienced climber in glacial travel should be the lead climber; however, if crevasses are completely masked, the lightest climber may lead. During moderate climbs, three climbers tied into a 165-foot rope is ideal. During severe climbs requiring belay, a 120-foot rope with only two climbers is recommended. If a two-person climbing team falls, the team must be arrested by a single axe. If a three-person climbing team is roped in, the rope is usually so shortened that if one climber falls, the others are often dragged in before they have time to react.

(3) Roping-In. Climbers are roped together by constructing figure-eight knots at the ends and middle of the rope. The rope is attached by passing a locking carabiner through the figure-eight and the crotch strap of the seat harness. Associated climbing equipment such as ice axes, slings, and packs are donned. When completely roped in and prepared for travel, there should not be less than 50 feet of rope between each of the climbers. The more rope between the climbers, the better the chance for a successful arrest.

c. Glacier Travel. Due to the difficulty of crevasse rescue, two or more rope teams are recommended for glacier travel since a single team is sometimes pinned down in the arrest position and members are unable to free themselves to begin rescue. Rope teams must travel close together to lend assistance to each other; however, not so close as to fall into the same crevasse. During extended periods on a glacier, skis and snowshoes are often of great value. This footgear will distribute the weight more widely than boots alone and place less strain on snow bridges. Neither skis nor snowshoes are substitutes for the rope, but may be used for easy travel.

(1) Operations in the mountains have certain limitations imposed by nature in glacial movement. Access to the end portion of a glacier may be difficult due to abruptness of the ice and possible presence of crevasses. Additional obstacles of mounting a glacier may be swift glacial streams or abrupt mountain terrain bordering the glacier ice. The same obstacles may also have to be negotiated when dismounting or mounting a valley glacier at any place along its course. Further considerations to movement on a glacier are steep sections, heavily crevassed regions, and icefalls. The use of up-to-date aerial photographs, when available, with aerial reconnaissance is a valuable means of gathering advance information about a particular glacier. The photos, however, only supplement and do not negate the advantages of surface reconnaissance conducted from available vantage points.

(2) Trail wands are used to mark the route and crevasses. The wands, especially essential to safety during periods of adverse weather, are placed every 150 feet along the route and can be used during day or night. A climbing team should not cluster close together during rest stops. If areas of safety cannot be found, the rope must be kept extended during rests just as during travel. A party establishing camp on a snow-covered glacier similarly remains roped-in for as long a period as required to safely inspect the area by stomping and probing the surface thoroughly before placing trust in the site. Hidden crevasses should always be assumed to exist in the area.

(3) Normally a team will travel in single file, stepping in the leader's footsteps or in echelon formation (figure 22-69). If a crevasse pinches out, an end run must be made (figure 22-70) even if it involves traveling half a mile to gain a few dozen feet of forward progress. The time taken to walk around is generally much less than in forcing a direct crossing. Important to remember in an end run is the possible hidden extension of a visible crevasse. A frequent error is aiming at the visible end. Unless the true or subsurface end is clearly visible during the approach, it is best to make a wide swing around the end.

(a) In late summer, the visible end is often the true end due to surface snow and ice having melted. When end runs are impractical because of the distance involved or because the end of one crevasse is adjacent to another, snow bridges may provide a crossing point. One kind consists of remnant snow cover sagging over an inner open space. Another kind, with a foundation which extends downward into the body of the glacier, is less a bridge than a solid area between two crevasses.

(b) Any bridge should be closely and completely examined before use. If overhanging snow obscures the bridge, the lead climber must explore at closer range by probing the depth and smashing at the sides while walking delicately, ready for an arrest or sudden drop. The second climber establishes a belay (figure 22-71) anchored by the third climber who is also prepared to initiate rescue if the leader falls. An excessively narrow or weak bridge may be crossed by straddling or even slithering on the stomach, thereby lowering the center of gravity and distributing the weight over a broader area. When there is doubt about the integrity of a bridge, but it is the only possible route, the lightest climber in the team should be the first across, with the following climbers walking with light steps and taking care to step exactly in the same tracks.

(c) Bridges vary in strength with changes in temperatures. In the cold of winter or early morning, the thinnest and most fragile of bridges may have incredible structural strength. However, when the ice crystals melt

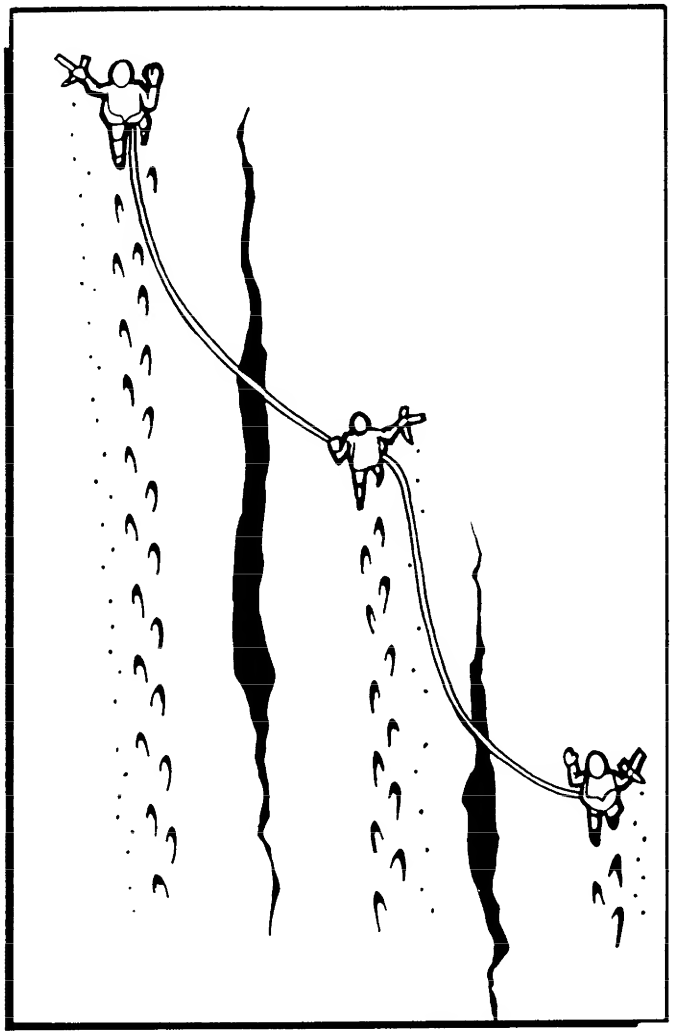


Figure 22-69. Echelon Formation.

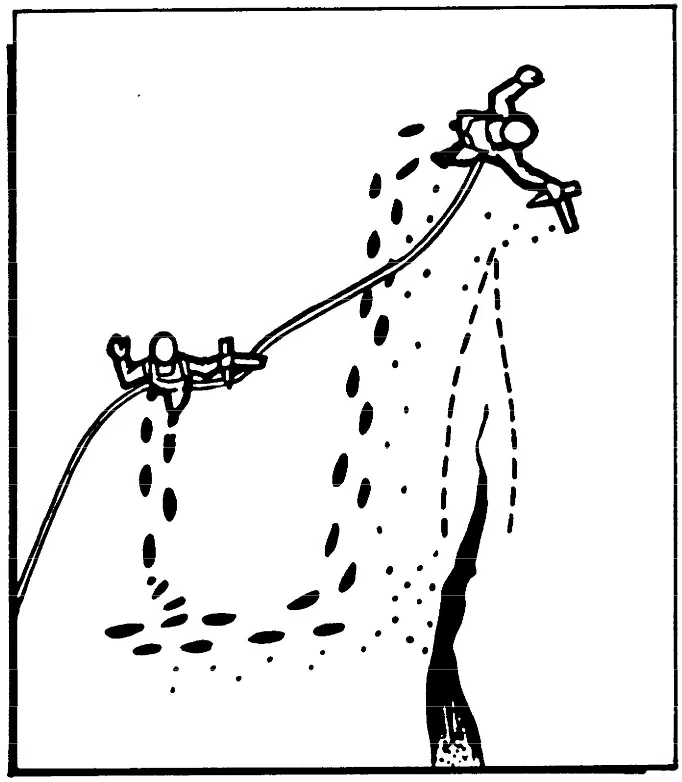


Figure 22-70. End Run.

in the afternoon temperature, even the largest bridge may suddenly collapse. Each bridge must be tested with care, being neither abandoned nor trusted until its worth is determined (figure 22-71).

(d) Narrow cracks in a bridge can be stepped across, but wider crevasses require jumping. If the jump is so long that a run is required, the approach should be carefully packed. A running jump (figure 22-72) can carry the climber further than a standing jump, although running jumps are not often practical. Most jumps are made with only two or three lead-up steps. In any case, care must be taken to locate the precise edge of the crevasse before any attempt is made to jump. Encumbering clothing and equipment must be removed before the jump, although the jumper must bear in mind the low temperature which often exists within crevasses.

d. Crevasse Rescue. Each climber must be able to effect a crevasse rescue if a team member falls into a crevasse. When a climber falls, the remaining team members must drop into a self-arrest position and stabilize their positions. All climbers should never be dragged into the crevasse. If a climber falls, the remaining team members must support the weight until one of them can establish a reliable anchor point or until the second team arrives to help. If the fallen climber is able to assist the recovery, self-extraction from the crevasse may be performed by using prusiks.

(1) A problem inherent to crevasse rescue is the imbedding of the rope (caused by the fallen climber's weight) in the ice and snow. Unless the rope is buffered with an ice axe during the climb out, it will tend to entrench itself deeper into the ice, eventually creating a deep groove in which it will be extremely difficult to use and retrieve, or it will freeze in place, rendering it useless. Corrective actions are to travel down along the rope, taking care not to drop debris on the climber, and free it from the ice. An additional method is to drop a spare rope down to the climber who shifts weight off the imbedded rope until it can be freed.

(2) If the climber is using prusiks and the action of the climb seesaws the rope into the tip of the crevasse, it will be extremely difficult to ascend the few remaining feet. A procedure to overcome this situation is for the climber to tie into the rope near the prusik. The climber then strikes the figure-eight knot from the harness and sends the end to the team above via a retrieving line.

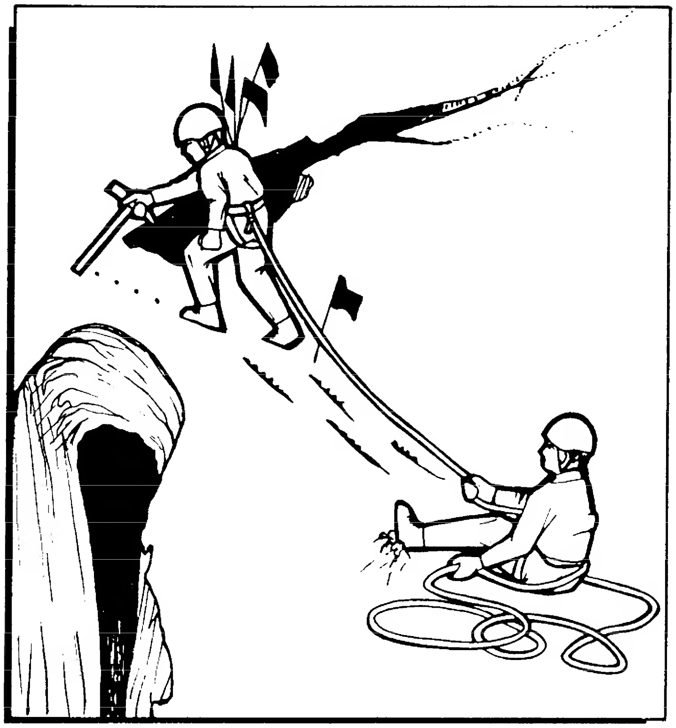


Figure 22-71. Crossing Bridged Crevasse.

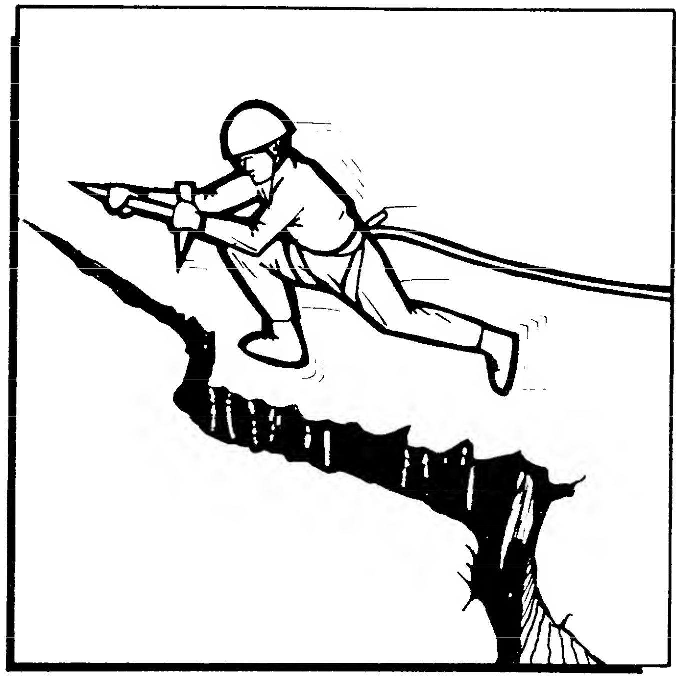


Figure 22-72. Jumping a Crevasse.

Once firmly anchored in place, the rope affords a viable route of ascent. Negotiating the final few feet of a crevasse is usually difficult due to the pressure of the rope against the lip or side of the wall. Prusiks tend to compress against or gouge into the wall rendering them nonfunctional. In most cases, the final few feet are overcome by brute strength. If a second rope is available, an alternate method can be used (figure 22-73).

(3) If a fallen climber is unable to help in the recovery, another climber may be required to enter the crevasse. Before the team member is lowered, all assurances must be determined that the assistance will enhance the outcome of the operation and not compound it. The rescuer should administer medical treatment as required, paying special attention to preventing or treating cold weather injuries as the interior of the crevasse can become extremely cold. Warm protective clothing must be used if the medical situation does not permit immediate extraction.

22-15. Evacuation Principles and Techniques. The performance of mountain rescue is not only physically demanding, but also mentally challenging. Hard and fast procedures to fit all circumstances for mountain rescue cannot be established. The team's ability to innovate will, in most instances, allow the adaptation of the basic principles, techniques, and procedures into a system suitable to effect the rescue. A normal rescue system will use anchors, belays, and various specialized systems. There are basically two methods of rescue: bringing the victim (patient) up to the rescuer's position, or evacuating the victim down from the position.

a. Safety. The establishment of rescue systems must be thoroughly tested prior to use. One missed step in setting up a rescue system may result in further injury of the victim and (or) injury to the rescuers.

b. Evacuations. Evacuation of a victim from the position in a downhill direction is an easier task than establishing a mechanical leverage for pulling a victim to the top of a hill. The victim's medical condition will dictate the method of evacuation and equipment used. The primary litter used is the Stokes litter. This is a tubular frame litter with a wire basket. The tubular main bar provides a very strong framework for mountain operations. The patient may be secured in the litter by means of several cross-body straps, or by the interlacing of slings. When an evacuation team arrives on the scene, there are two activities which should take place at the same time: (1) The patient should be treated and prepared for transporting in the Stokes litter, and (2) the anchor and mechanical brake system must be established. Within obvious restraints of time and distance, low-angle evacuations are always preferable to high-angle evacuations. Low-angle work eliminates many hazards and requires a lesser degree of knowledge and skill. Using the Stokes litter eliminates excessive knot tying and lashing essential on other litters.

c. Preparing the Braking System. The following describes the preparation of the brake system for a low-

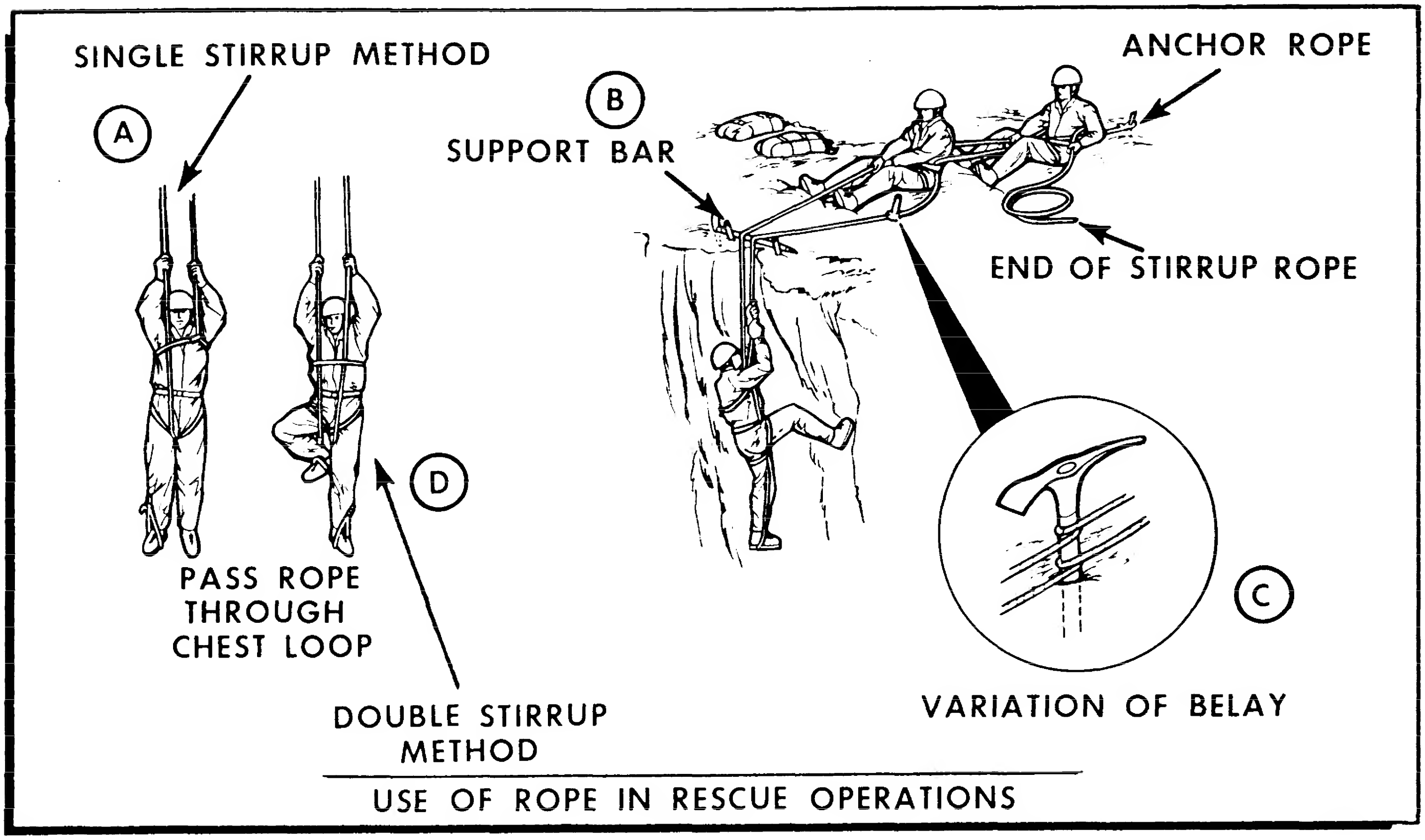


Figure 22-73. Two-Rope Crevasse Rescue.

angle litter evacuation. Establish a very sound anchor, which will be in the direction of pull for the first pitch. If a sound anchor is not available, establish an anchor system. If the terrain does not allow the brake operator ample room to safely and effectively perform the required tasks, than an 11 mm (seven-sixteenth inch) rope sling or double tape sling can be used to adjust for the distance from the anchor to the area where the brake operator will work. The mechanical braking device is securely attached to the anchor or sling. This braking device should either be a figure-eight rappel ring, or a four-carabiner brake system. The rope to be used for the litter descension should be backcoiled. If the rope is to be used for ascending, the rope should lay out along the route of ascension. The head of the litter will be attached to the figure-eight at the end of the rope with a steel-locking carabiner. If locking carabiners are not available, the rope should be tied directly to the litter using several round turns on the outer rail at the head of the Stokes litter and tied off with a bowline and a safety knot. The rope is then properly locked into the mechanical braking system.

d. Preparing the Patient for Transport. While the rope and brake system are being prepared, the litter and patient should also be prepared. The litter must be secured to prevent its loss or further injury to the patient. Additionally, the litter may be padded or insulated (blankets or foam pads) for protection. The ties for securing the feet and pelvis should be attached to the litter. Before evacuating, all emergency medical treatment appropriate to the situation should be performed (splinting fractures, maintaining an open airway, etc.). The patient should be insulated from environmental conditions such as cold, wind, or rain. The person in charge of the patient's medical condition should ensure that the patient's condition is stable enough for transporting. In mountainous terrain, the patient should be protected from further injury due to rockfall by wearing a helmet at all times. A litter team generally consists of four to six people. Fewer than six cannot withstand the fatigue of frequent or long trips while carrying an injured person.

e. Three- or Four-Man Lift. Three bearers take up positions on one side of the victim, one at the shoulder, one at the hip, and one at the knees. If one side is injured, the three bearers should be on the uninjured side. A fourth bearer, if available, takes a position on the opposite side, at the victim's hip.

(1) The bearers should kneel next to the victim. Then, simultaneously, the bearer at the victim's shoulder puts one arm under the victim's head, neck, and

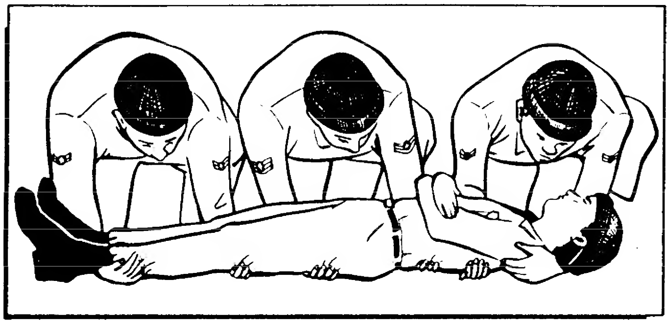


Figure 22-74. Lifting the Patient.

shoulder, and the other under the upper part of the victim's back. Each bearer at the victim's hips places one arm under the victim's back and the other under the victim's thighs. The bearer at the victim's knees places one arm under the victim's knees and the other under the ankles (figure 22-74).

(2) The person at the victim's head gives all the commands. The command "prepare to lift!" is followed by the command "lift." Immediately, all the bearers lift simultaneously and place the victim in line on their knees. If the victim needs to be moved any distance to the litter, move as shown in figure 22-75.

(3) The fourth bearer, if available, places a stretcher under the victim and against the toes of the three kneeling bearers. The command "Prepare to lower!" is followed by the command "Lower!" and the victim is gently lowered to the litter. Once properly positioned in the litter, the victim must be secured in a manner to prevent further injury. The victim may be secured to the litter in a variety of ways depending upon the evacuation route and the victim's condition.

f. Securing Patient in the Litter:

(1) The tape sling used to secure the feet is tied to the framework of the Stokes litter which separates the legs near the groin area. The tape sling should be tied with a clove hitch in the middle of the tape in a manner to prevent the tape from sliding down to the feet when pulled tight. The feet are secured by running the tape across the legs to the window on the outside of the litter then across the patient's legs to the feet. An overhand knot is made in each tape which can be passed over the corresponding foot. When the feet are secured, there should be ample room to apply tension to the head if needed. The tape is then tied at the foot of the litter to a major support bar on the inside of the litter frame. The ties on a Stokes litter should never be made on any outside rail as they are subject to abrasion. The tape slings should be tied off with a two-round turn and two half hitches. If the two-round turn does not hold tension, then a clove hitch can be used in its place.

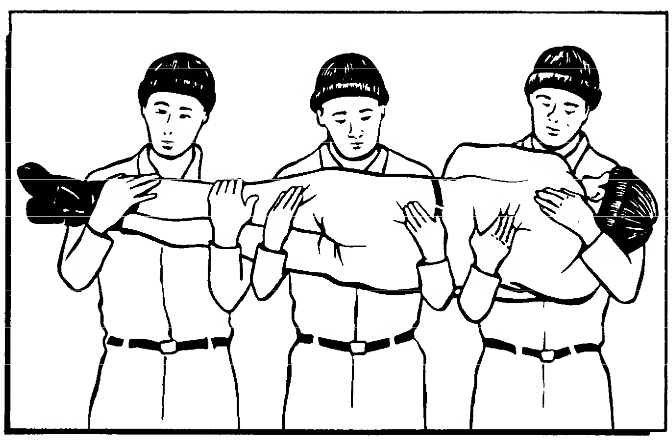


Figure 22-75. Moving the Patient.

(2) The tape used to secure the pelvis should be tied just above the tape used to secure the feet, and secured in the same fashion. Each end of the rope is passed over the leg to the larger upright cross-member of the Stokes litter between the outer rail and inner basket rail. This cross-member corresponds with the side of the hip. The tape is secured with a two-round turn and two half hitches or a clove hitch and two half hitches. The ends of the tapes are then tied together at the middle of the patient's waistline with a square knot and two half hitches on either side of the knot.

(3) The upper torso is secured by placing the middle of the tape in the center of the patient's chest and the two ends of the tape are secured to the large upright cross-member. The running ends of the tape are then passed diagonally across the patient to the cross-member which is next to the abdomen. The tape is secured again and the ends are tied at the midline of the body. The head is secured by running a tape sling over the helmet and securing the tape at the corresponding cross-members. The helmet can be used with a tape sling to provide traction; however, it is not a substitute for the neck collar (figure 22-76).

(4) Once the patient and the system are ready for the low-angle evacuation, the entire system must be doublechecked. Once the litter and patient are prepared as described, ascent or descent is made through a team of litter bearers and a belay point. The minimum essential members for a low-angle evacuation are five—a belayer and four litter bearers (figure 22-77).

g. Low-Angle Evacuation Descent. On the descent, the belay rope attached to the head of the litter runs through a mechanical belay brake system. One team member acts as the belayer. This secures the litter and aids in lowering. Another person may assist the belayer with the rope. Litter bearers take their positions on the litter, ideally three on each side. The chief medic and crew boss should be among these to ensure the patient is

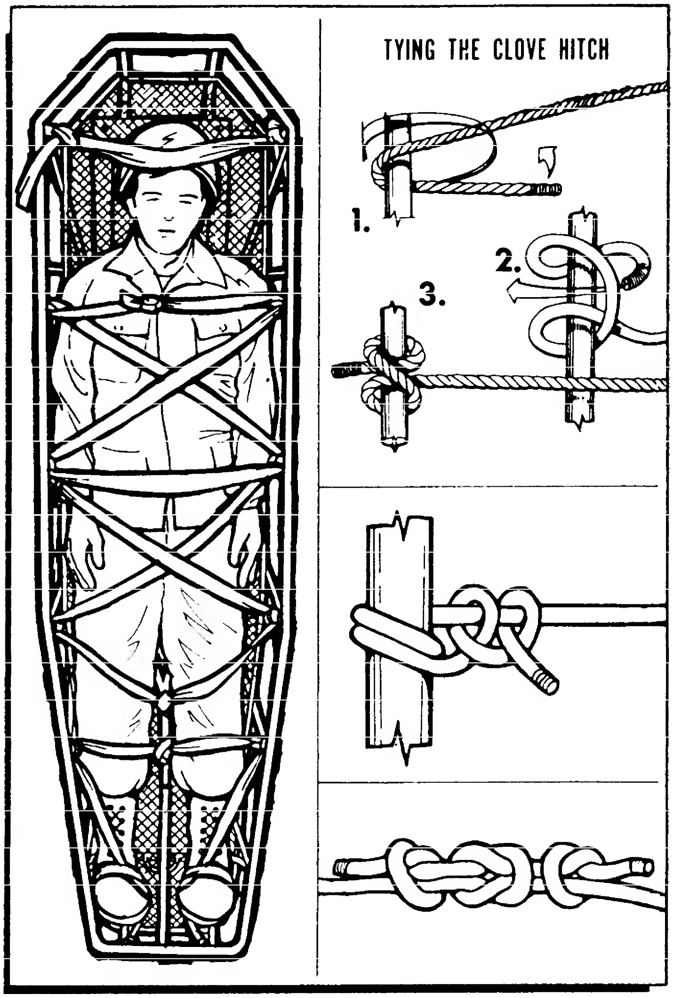


Figure 22-76. Tying the Patient into a Stokes Litter.

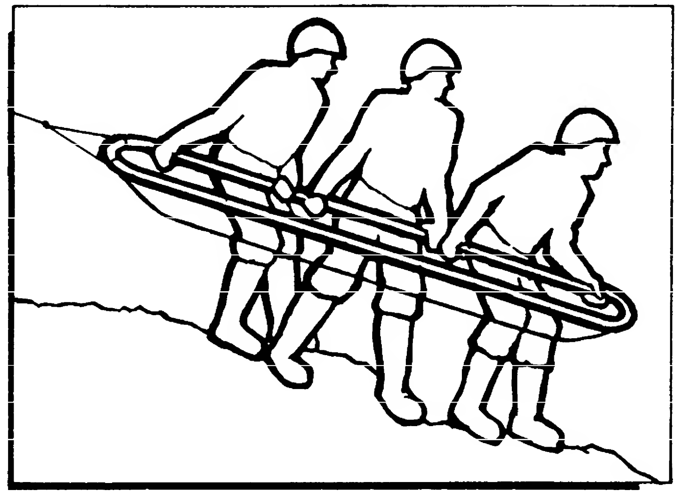


Figure 22-77. Carrying the Litter.

monitored 100 percent of the time and that effective communication exists between the litter bearers and the belayer.

(1) In descending, the most direct, practical passage which takes advantage of available trees and rocks for belay points should be used. Communication is made through a series of commands. As litter bearing is rapidly exhausting, team members should alternate roles. Additionally, a sling attached with a girth hitch to the litter may be used to transfer some of the weight from the arm to the skeletal system via the shoulder. It is also advantageous to use the belay system brake by leaning forward, thus reducing the amount of lifting required.

(2) The scout may precede the team to pick a trail, make the passage more negotiable, or make a reconnaissance so the team need not retrace its course if an impasse is encountered. The scout can also select the site for and secure the next anchor. The scout must remember that the anchors and belay stations must be less than 140 feet apart (with 150-foot rope). Any time the route of descent or ascent changes course more than 90 degrees, a new anchor and brake system must be established or a runner used to change the direction of pull from the belay to the litter. In addition, if the rope is binding against vegetation or rock formations, a sling with a carabiner should be used to pull the rope away from the obstacle.

(3) Once all rescuers have been assigned positions and understand their responsibilities, the litter can be moved. The crew boss will count to three and give the command to lift. The crew boss should coordinate the litter bearers' activities while moving over rough terrain. Standardized commands between the crew boss and belayer are used to control the rate of descent. The following are the commands which should be used:

(a) "ON BELAY?" - Crew boss.

(b) "BELAY ON" - Belayer.

(c) "ROPE" - The crew boss is telling the belayer to feed the rope out in feet.

(d) "SLOW ROPE" - The crew boss is telling the belayer to feed the rope out in inches.

(e) "BRAKE" - Can be said by anyone to avoid a fall or obstacles.

(f) "LITTER SECURE" - The crew boss is telling the belayer that the litter will not be moving and it is attached to the anchor.

(g) "OFF BELAY" - The crew boss is telling the belayer to break the belay system and begin moving equipment to the next station.

(4) When ascending a steep slope, the procedures described in the descent are generally reversed. Additional manpower is required to pull the belay rope through a four-carabiner brake system or figure-eight clog while the litter bearers lift and slowly climb. One person is required to operate the brake system. As this procedure is considerably more fatiguing than descending, the litter bearers should not try to do all the work.

However, as they are ascending the slope, they should assist and hold the litter off the ground.

h. The Buddy System. The buddy system is an evacuation for a slightly injured patient or a patient who is incapable of getting off a precipice. Equipment required is two climbing ropes, four slings, chest, and seat harness for the rescuer, optional seat harness for the patient, and sufficient equipment to construct an anchor system. The following steps are necessary:

(1) An anchor system is set up with a belay device. The first rope is backcoiled as a belay line. A figure-eight knot is tied in the end of the rope with a fisherman's safety.

(2) The second rope is coiled with large enough coils to fit around the shoulders of the patient and the rescuer (figure 22-78). Once coiled, the loops are divided into two groups so that a figure eight is formed. The patient steps into the divided coil so that each leg is through one-half of the figure eight. The knot securing the coil should be in the small of the patient's back, and the coils should be beneath the patient's arms.

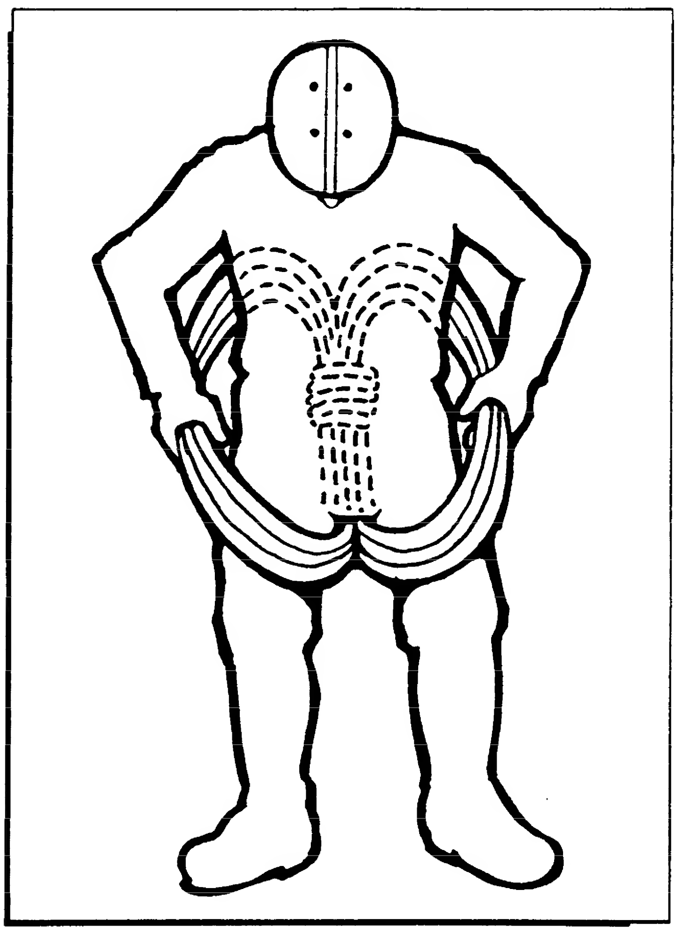


Figure 22-78. Preparing Patient for Buddy Evacuation System.

(3) The rescuer then stands in front of the patient and places each arm through the loops of the coil, half over the right shoulder and the other half over the left shoulder (figure 22-79).

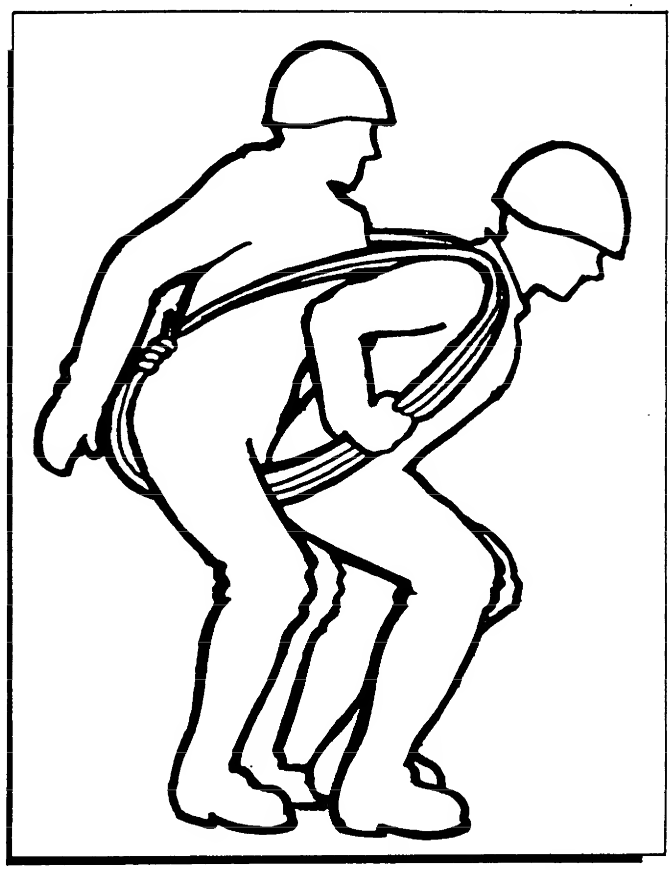


Figure 22-79. Rescuer Donning Rope and Patient.

(4) A sling is passed around the back of the patient, passing under the arms and over the shoulders of the rescuer. The sling is then wrapped around the coil as it passes over the front of the rescuer's shoulders (figure 22-80). The working ends of the sling should pass over the top of the loop formed in the wrap. Ensure the wrap is made low enough not to cross the rescuer's neck or interfere with breathing. The two ends are tied together in the center of the rescuer's chest using a square knot. The tails are taken down to the rescuer's seat harness, one tail is passed through each side, tied in a loop of the harness, and back up to the square knot. Here they are secured to the rope between the coil and square knot by a clove hitch knot on each tail (figure 22-81).

(5) To attach the party to the belay rope, the figure-eight knot on the end of the belay rope is attached to the carabiner on the crotch strap of the seat harness of the rescuer. The two tie end loops are secured with a carabiner sling; another sling is connected to the rescuer's chest harness and the belay rope with a prusik knot (figure 22-82). This sling is used to support the addition-

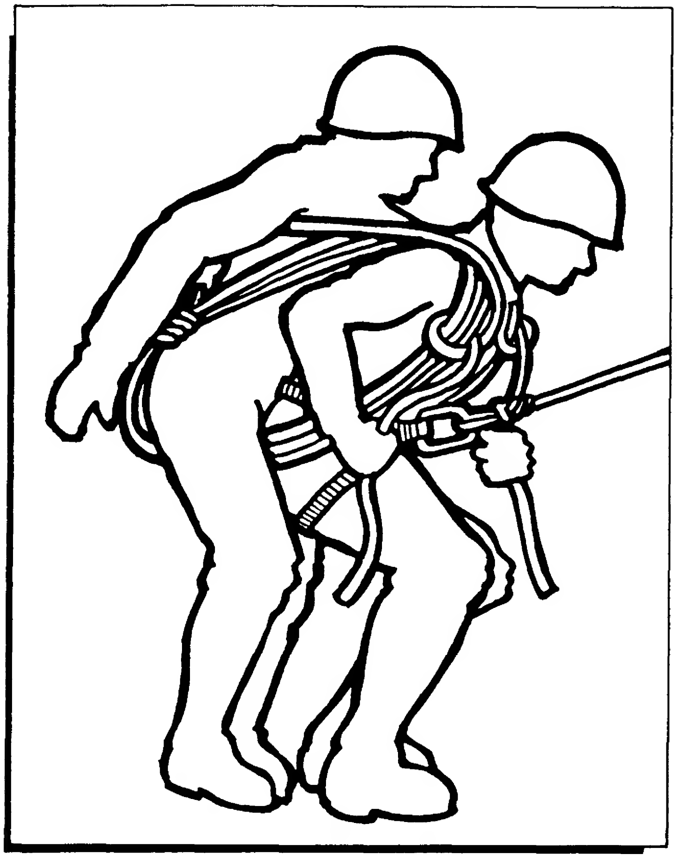


Figure 22-80. Securing the Patient for Buddy Evacuation.

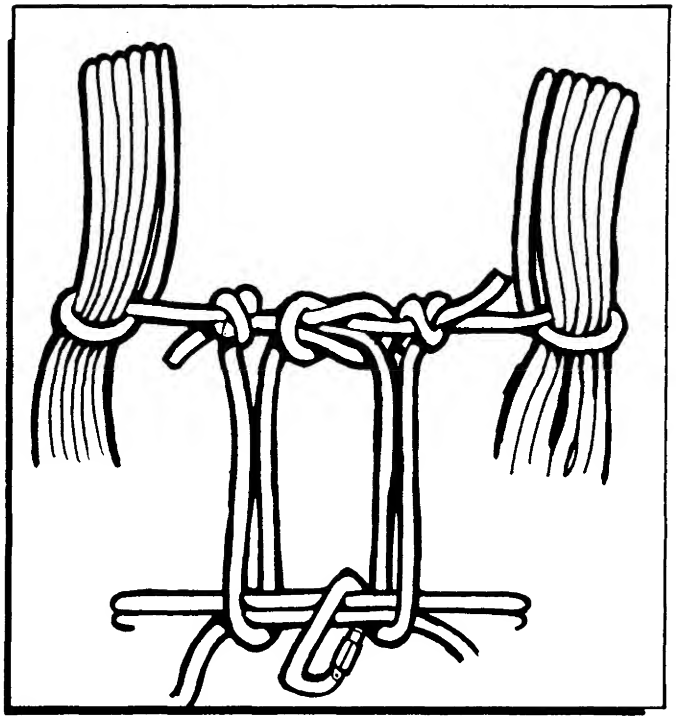


Figure 22-81. Tie-In Procedures.

al weight of the patient. This will enable the rescuer to remain perpendicular to the surface of the rock. Without this sling, the rescuer would fall over backward. The sling should be short enough so the rescuer can adjust the sling during the evacuation. The two people are then belayed down using a mechanical braking device (four-carabiner brake). (See figure 22-82.)

(6) The commands are:

(a) "ON BELAY?" - Given by rappeller.

(b) "BELAY ON" - Given by belayer.

(c) "BRAKE" - The belayer will stop the descent.

(d) "ROPE" - Belayer repeats "Rope." The belayer will feed the rope out in inches.

(e) "PATIENT SECURE" - Given by rappeller.

(f) "THANK YOU" - Given by belayer. The patient and the rescuer are in a safe location from rockfall and will not fall.

(g) "OFF BELAY" - Given by rappeller.

(h) "BELAY OFF" - Given by belayer. The rappeller is no longer secured by the belayer and the belayer can disconnect from the system.

i. Vertical Litter Evacuation. The vertical litter evacuation is used in areas where a horizontal descent is not possible. The patient is secured to the litter in the same manner as for a horizontal evacuation. Two ropes are used for the vertical evacuation. The belay rope to the litter is configured with a figure-eight knot and a locking steel carabiner. A double-tape sling is passed between the two steel frame bars forming the main body at the head of the litter (figure 22-83). The sling should pass outside of the four joining bars between the frame bars. Both ends of the sling are connected into the belay rope carabiner. Two carabiners are connected to the windows on one side of the litter. The second rope runs down the side of the litter through these carabiners to finish at the foot of the litter. A figure-eight knot is tied in the end of the rope. The seat harness of the barrelman attaches to this knot. A figure-eight knot is tied in the end of the sling and a carabiner clipped into the knot and connected to the foot of the litter (figure 22-84). A knot is added to the other end of the sling. A carabiner is added to the mariner's loop and connected to the barrelman's chest harness. As in the horizontal evacuation, the commands are given by the barrelman. The commands are the same as in the high angle horizontal litter evacuation (figure 22-85).

j. Horizontal High Angle Litter Evacuation. The horizontal litter evacuation is the preferred position for an injured patient. This position allows for easier medical treatment and is required for shock prevention. The danger of this position is the patient's exposure to rockfall. Because of its complexity, it is also the most

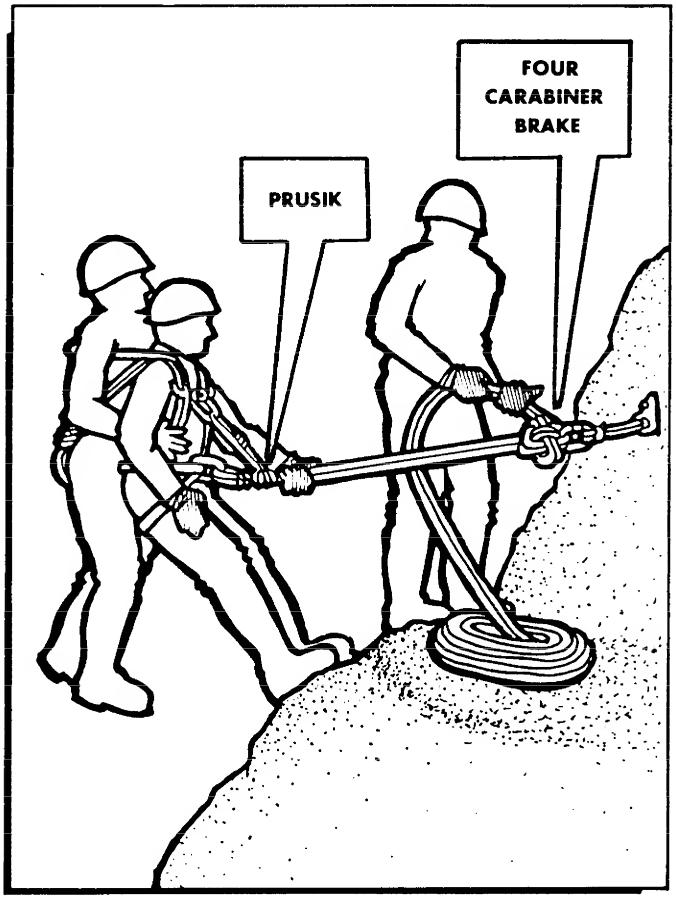


Figure 22-82. Hookup for Buddy Evacuation.

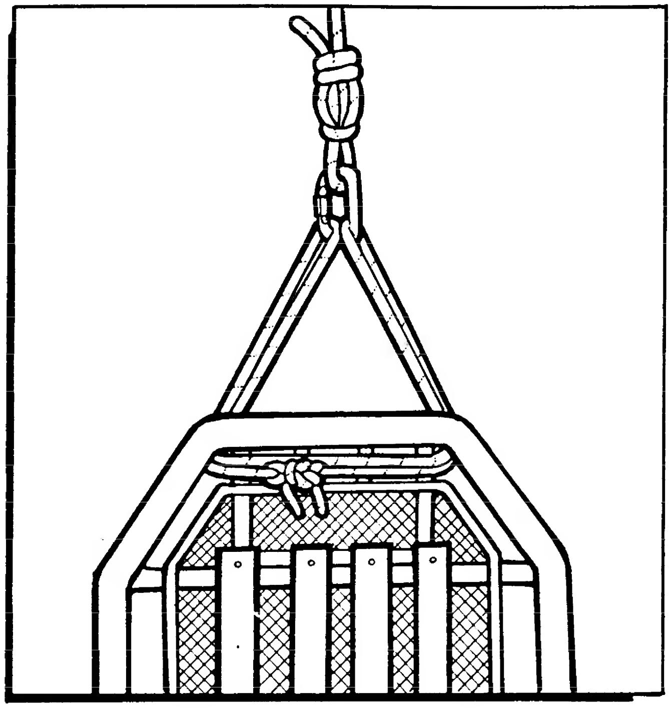


Figure 22-83. Attaching Rope to Stokes Litter.

potentially dangerous evacuation and should not be done unless no alternative exists.

(1) Team Composition. This method requires a minimum of three highly qualified team members. It also requires a great deal of equipment. It should not be attempted without the required equipment and qualified team members. Because the relative nature of the high-angle litter evacuation is potentially dangerous, the margin of safety must far exceed the stress on equipment. The safety factor is greatly increased by using equalizing anchors, two ropes for lowering a belayer, a rope handler, and a mechanical brake system. The high-angle evacuation on vertical walls is performed by only one litter bearer with the litter fully supported by the lowering ropes. However, on walls which are not vertical, it requires a great deal of strength to pick up the litter and walk it down. When an injured victim is on a steep wall, a second person will administer first aid and then assist in loading the victim into the litter. In fact, this "second person" may perform the technically most difficult part of the evacuation in loading the injured person. In some cases, a "third person" can help load a severely injured patient. The job of the barrelman is to get the litter to the victim, to see that the victim is properly loaded and secured, to give the victim a smooth evacuation by preventing the loaded litter from knocking against the rock, and to administer first aid to the victim if necessary. For first aid purposes, the litter should normally be horizontal. Proper operation of the brake controlling the litter is essential.

(2) Rigging the Litter. Two 7/16-inch Mountain Lay ropes are used for lowering, each terminating in a figure-eight knot with a 4- to 5-foot tail, attached to a large locking steel carabiner. Each tail will terminate with a figure-eight knot and safety knot. One end will be attached to the seat harness of the barrelman and the other will be attached to the patient. These ropes should be the same length for ease in rope changes, and ideally the ropes will also be matched in elasticity and of similar wear. The spiders are the nylon slings, between 30 to 36 inches long, which attach the litter to the rope. These spiders are attached to the litter with large locking carabiners. These large carabiners are clipped over the outer rail of the Stokes litter and should have their gates facing in and locked (figure 22-86). If these carabiners are not available, the spiders can be attached to the major upright supports in the window of the litter with a double round turn and two or more half hitches. There are four spiders. One group of two spiders is attached to the windows at the sides of the litter at the head. The head group of two spiders is attached to the window at the sides of the foot of the litter. The spider groups should be connected with the key locking carabiner. This carabiner is attached to both of the ropes (figure 22-87). The

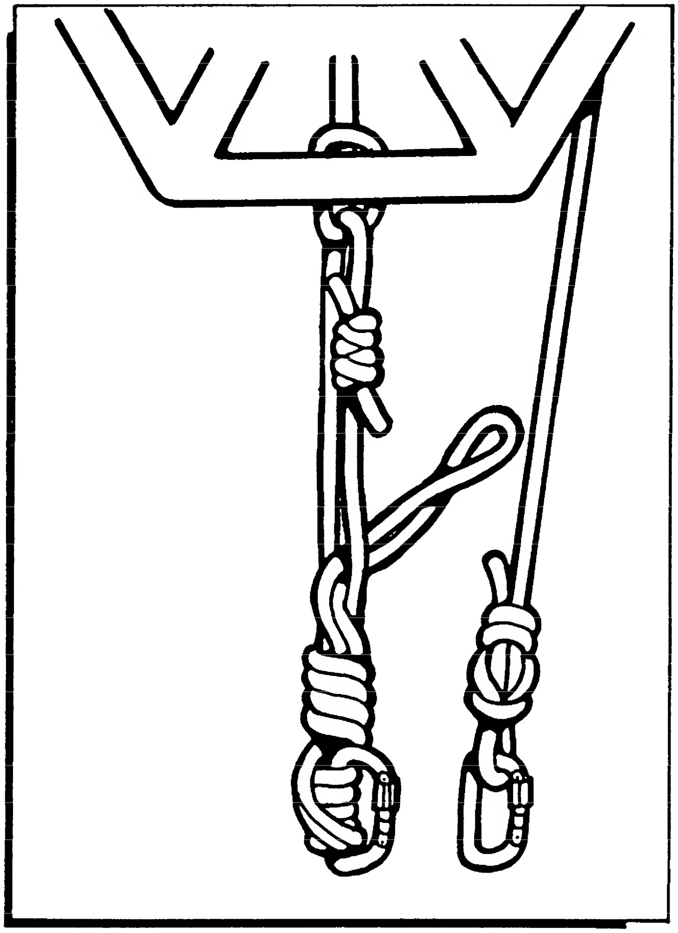


Figure 22-84. Tie-Ins for Foot of Litter.

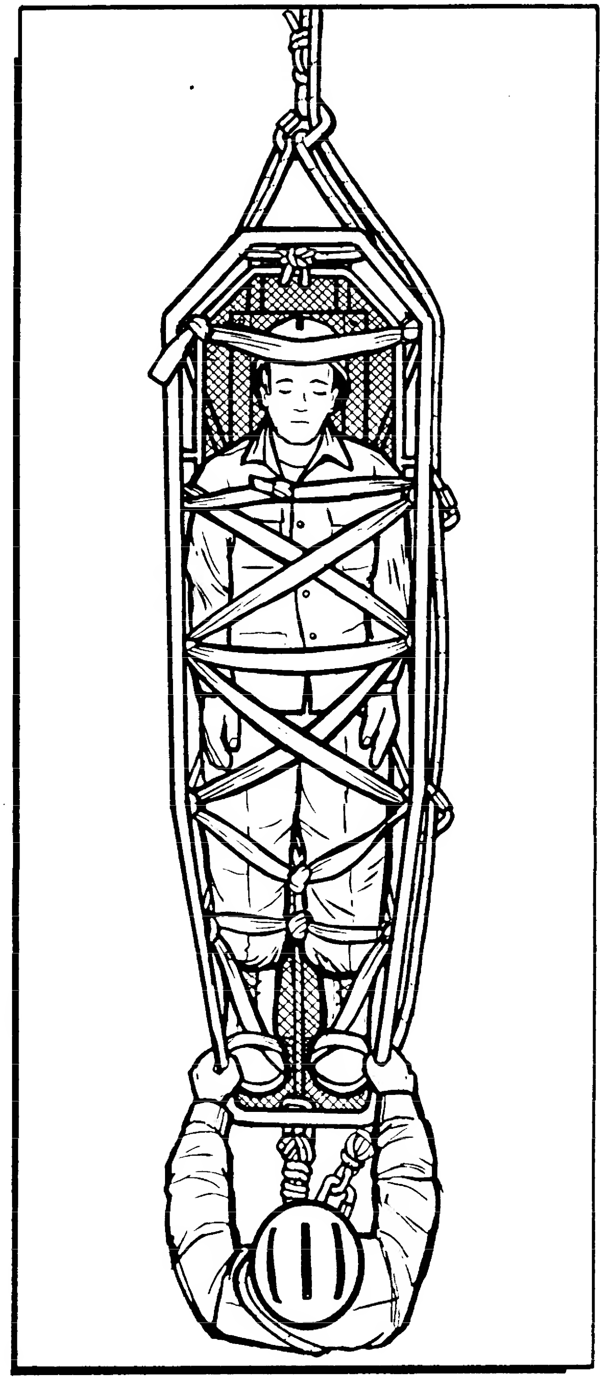


Figure 22-85. Horizontal Descent of Litter.

spiders should be adjusted so the litter is horizontal or with the head only slightly elevated. The patient is tied into the litter in the same way as for the low-angle litter evacuation. However, the patient should have a chest or seat harness on. The figure-eight knot from one of the lowering ropes must be attached to the chest harness with a standard locking carabiner.

(3) The Barrelman. The barrelman is attached to the other lowering ropes by the figure-eight knot at the end of this rope. This rope is attached to the barrelman's seat harness with a standard locking carabiner. This is a safety line only. The majority of the barrelman's weight is supported with a 7 mm line which attaches the barrelman's seat harness with a standard locking carabiner to the key character. This line is secured with a prusick or Bachman's knot. The mariner's knot can be adjusted so the rescuer's feet are flat on the rock below the Stokes litter. The rescuer should be able to shield the patient with the upper body.

(4) Anchors. The anchor location should be directly above the victim if possible. For an evacuation on a large face when visibility is good, a spotter on the ground with a plumb bob can direct an accurate alignment of the anchor over the victim by communicating to the people on top. If the cliff is not vertical, the observer must observe the cliff "hang-on" and must be in the vertical plane containing the fall line through the victim. If the cliff is irregular, the plumb bob technique may be unreliable, but the observer may still be the best source of information in locating the anchor. If the anchor is placed in such a way that the rope will have to pass over a sharp corner of rock at the lip of the face,

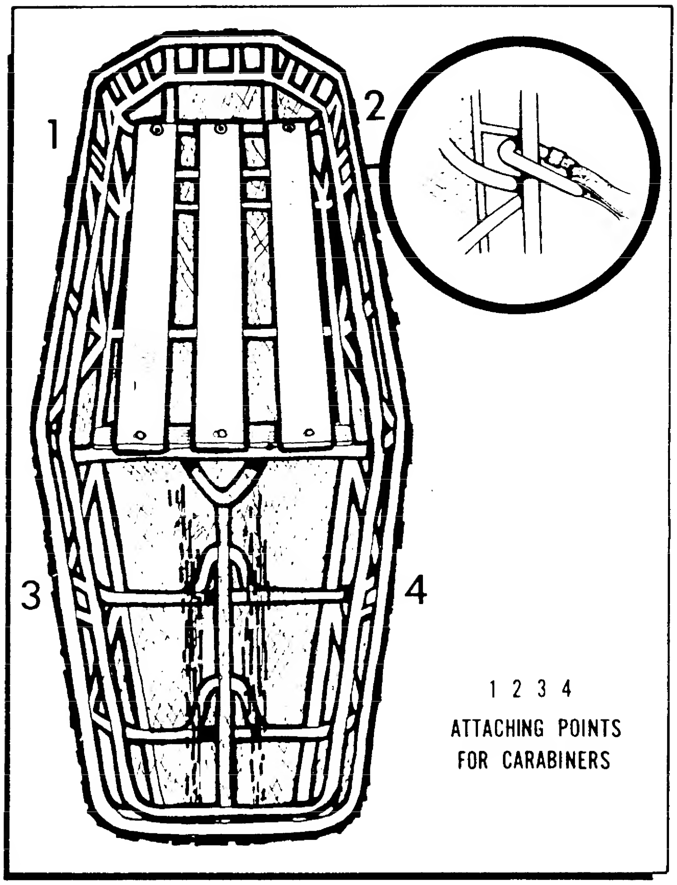


Figure 22-86. Attaching Points for Carabiners.

the corner should be "softened" by breaking the edge with a hammer and by securing padding. If possible, an equalizing anchor system (figure 22-88) should be used for anchoring the top brake systems. This is the safest anchor system to use because it will adjust for a shift in position and the shock load will be equally distributed if one of the individual anchors fail, the litter bearer falls, or the braking is of a fast descent.

(5) Braking System. The four-carabiner or figure-eight clog brake system can be used; however, the four-carabiner system is superior. This brake system will have a brake operator assigned. The brake operator obviously plays an important part in a successful evacuation, and should use gloves and avoid touching a hot braking device. To maintain full control while lowering, the brake operator should never let go of the ropes until tied off or "off belay." The operator should keep the descent smooth and steady, feeding the ropes equally into the brakes and never allowing a kink to form. A kink may jam in the brake and be difficult to release. Smoothness is easily produced if the loading by the litter is steady and has sufficient weight to require the brake operator to maintain a moderate grip on the rope and let the litter do the pulling. The litter should normally remain horizontal; thus the two lines lowering the ropes should be fed equally into the brake. The ropes may be grasped together by one hand and fed equally, even with unbalanced loads. It is often helpful to the brake operator to have a rope handler pull the rope which is not feeding rapidly enough through the brakes. This is particularly useful when the litter is lightly loaded.

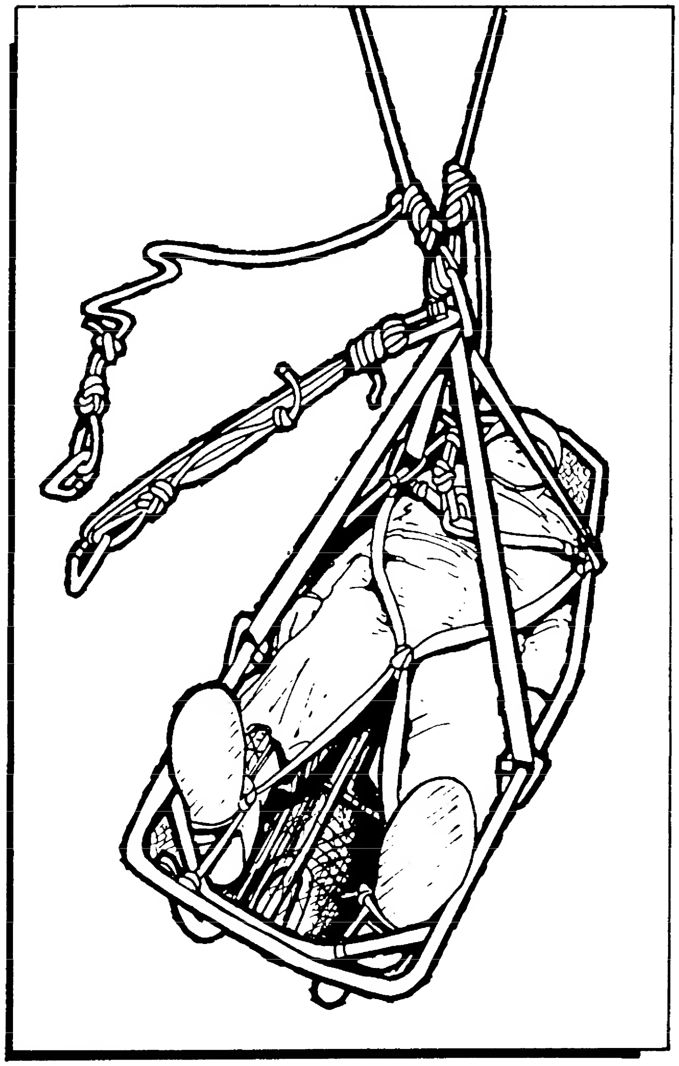


Figure 22-87. Rigging the Stokes Litter for Horizontal Evacuation.

(6) Rope Management. The proper management of the rope by the team at the top is essential for efficient evacuations. In fact, the overall job on top usually involves more thought and skill than is required by the litter bearer. The operations on top are best done by at least two people. The brake operator directly controls the speed of descent. A rope handler provides slack rope with no kinks to the operator and assists on the brake when required. The rope handler's tasks are crucial since the evacuation comes to a rapid halt if the ropes

become snarled. The ideal situation on top is to be able to lay the lowering ropes out in a straight line in their entire length. The rope handler will then have an easy time assisting the operator. If space is limited, the ropes can be stacked separately and neatly. There may be a tendency for the rope to kink at the brake, in which case the rope handler will stay busy twisting and spinning the slack rope.

(7) Handling the Litter. The barrelman will always wear a hardhat, pack, and gloves. The reason for this is that in case small rocks fall toward the helpless victim, the barrelman can lean over the victim providing a shield; and the packs and hardhats protect the barrelman. The victim will also wear a hardhat (when possible). A redundant barrelman tie-in is used for safety, and the locking of doubled carabiners should be used to prevent the barrelman tie-in from being accidentally released. Smooth handling of the litter by a skilled barrelman is the best way to ensure a safe ride down for the victim; banging the litter against the rock is very hard on the victim, and poor handling of the litter may result in injury to the barrelman. In starting the evacuation, the barrelman may have to carry the litter a short distance at the top of the face taking care that ropes are positioned over a smooth rounded edge of the cliff and the spider carabiners have gates facing in. Once their weight is on the lowering ropes, the barrelman's main job is to hold the litter away from the rock. The feet are used against the rock as they are in rappelling to maintain footing. The barrelman's position on a nearly vertical wall is to be hanging from the tie-ins which may be a comfortable seat sling. The barrelman (figure 22-88) is normally on the outside of the litter (away from the rock), gripping the outer or an underneath rail to hold the litter still farther off the rock to clear projections, etc., or to level the litter if loading is uneven. Occasionally, the rail at the cliff face is grasped, but care must be taken to avoid getting crushed hands.

(a) The descent is easy on flat, smooth, vertical walls. On a wall with obstructions, footwork techniques are the same as in rappelling. The legs should be perpendicular to the wall and spread comfortably apart. The Prusick or Bachman's knot should be adjusted so the barrelman moves the litter to the edge of a vertical face and may require readjusting so the space between the litter and the barrelman can be maintained. The barrelman will be bent at a 90-degree angle at the waist which will enable the barrelman to bend over to protect the patient or administer first aid.

(b) The litter must be secured to an anchor to keep it from sliding and falling. The lowering ropes should be removed from the spiders and the knots untied to allow the ropes to be hauled back to the summit without a knot jamming. The spiders themselves should not be dragged up the cliff because of the danger of jamming. Normally, the ropes will be pulled up and carried down rather than dropped because of the possibility of snagging or damage. After the evacuation is complete, the litter should be moved to an area sheltered from falling rock.

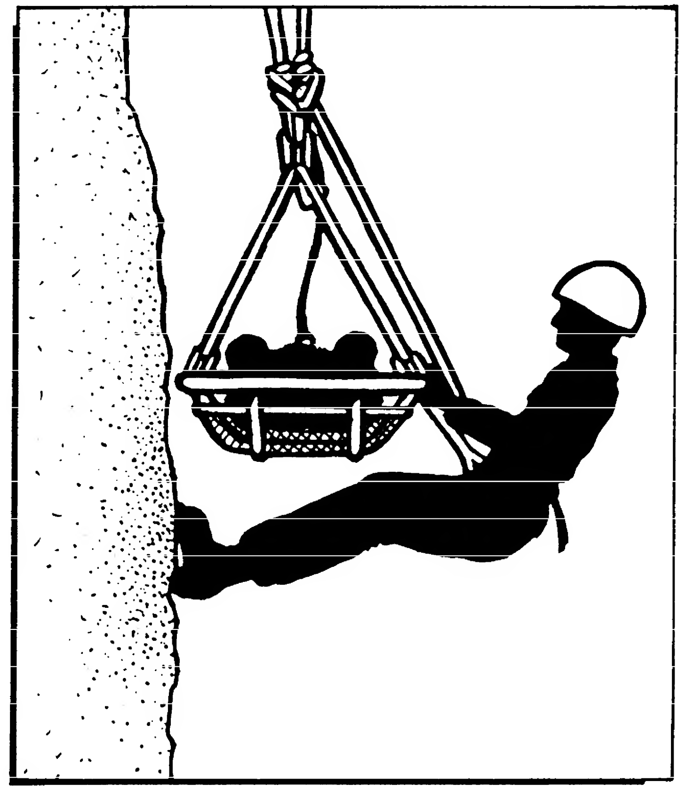


Figure 22-88. Body Position for Rescuer.

(8) Communication. The general goal of the brake operator is to lower the litter smoothy and safely as directed by the barrelman. The commands to be used are as follows:

(a) "ON BELAY" - Has the usual meaning and is used before the evacuation begins.

(b) "ROPE" - Means for the brake operator to feed the lowering ropes equally through the brake at a moderate speed.

(c) "SLOW ROPE" - Means for the brake operator to feed the lowering ropes equally through the brakes at a slow speed.

(d) "BRAKE" - Means for the brake operator to brake both lowering ropes simultaneously.

(e) "SECURE" - Means to maintain the brake until the litter is anchored or in a position where it will not fall.

(f) "UP ROPE" - Means the litter is detached and all knots and slings have been removed. The rope can be pulled up without becoming caught on rock outcroppings or in cracks.

k. Horizontal Hauling Lines and Tyrolean Traverse. A suspension system used to transport a load off the ground along a taut (static) line may be useful when

crossing streams, gorges, or other difficult terrain. These systems can be used for team movement or for transporting victims. The two-rope bridge is time consuming to set up, but in spite of the complexity the techniques can be useful in rescue. However, time should not be wasted waiting for the system to be set up. Sometimes the rigging may be done while the victim is being transported to the crossing site. Since system stresses are often great, the margin of safety is smaller than usual or desirable in rescue operations, and the rigging should be supervised by someone experienced in the techniques.

(1) Anchors. A major requirement for any suspension system is the availability of secure anchors at each end. Anchors have to be as strong for this use as in any mountain rescue. To withstand the high-line stress, the anchors may have to be a combination of several anchor points rigged to be self-equalizing. For reasonable safety, each anchor system should be able to hold at least 10 times the load to be transported.

(a) The anchors must be suitably placed in addition to being strong. To prevent the load from "bottoming out" or to minimize line tension by increasing sag, the anchors must be placed in a high location. If the rope contacts any sharp rock, the rock edges must be padded with suitable material such as leather gloves, pack, tree branches, etc., since a taut rope can be easily cut. The anchors should be 6 to 10 feet back from the edge of the stream or cliff to provide for loading and unloading. The rope should be 3 feet or more off the ground at these positions, and if good anchors do not allow this, A-frames may be improvised from sturdy tree trunks.

(b) If possible, two ropes or a double rope should be used to increase the safety margin. However, one rope will work although the strength of the system is decreased. It is very important to understand the stresses involved with this system. For example, if the rope span is 40 feet and the sag in the middle of the rope is 1 foot with a 200-pound load, the rope tension is approximately 2,500 pounds. However, if the sag is 4 feet in a 40-foot span, then the tension is 650 pounds.

(2) Establishing the Two-Rope Bridge. Connect the center of the rope through the anchor. Do not tie, but simply pass through a carabiner. If the span requires two ropes to be tied together, a double figure eight should be used with single fisherman safeties. A carabiner must be placed in the double figure eight; if not, the double figure eight will be difficult to untie. One team member will cross the obstacle carrying the two ends of the rope plus the hauling rope. Once across, an anchor is established and one end of the rope connected to it (figure 22-89). Remove as much slack as possible so the knot will be taut against a 4-inch pulley or carabiner on the opposite side when tied off to the anchor system. The other end of the rope is then put through a 3:1 mechanical advantage system.

(a) To use the mechanical advantage, a safety prusik is attached to the rope. This safety prusik must be attached to a stout anchor and be as long as practical

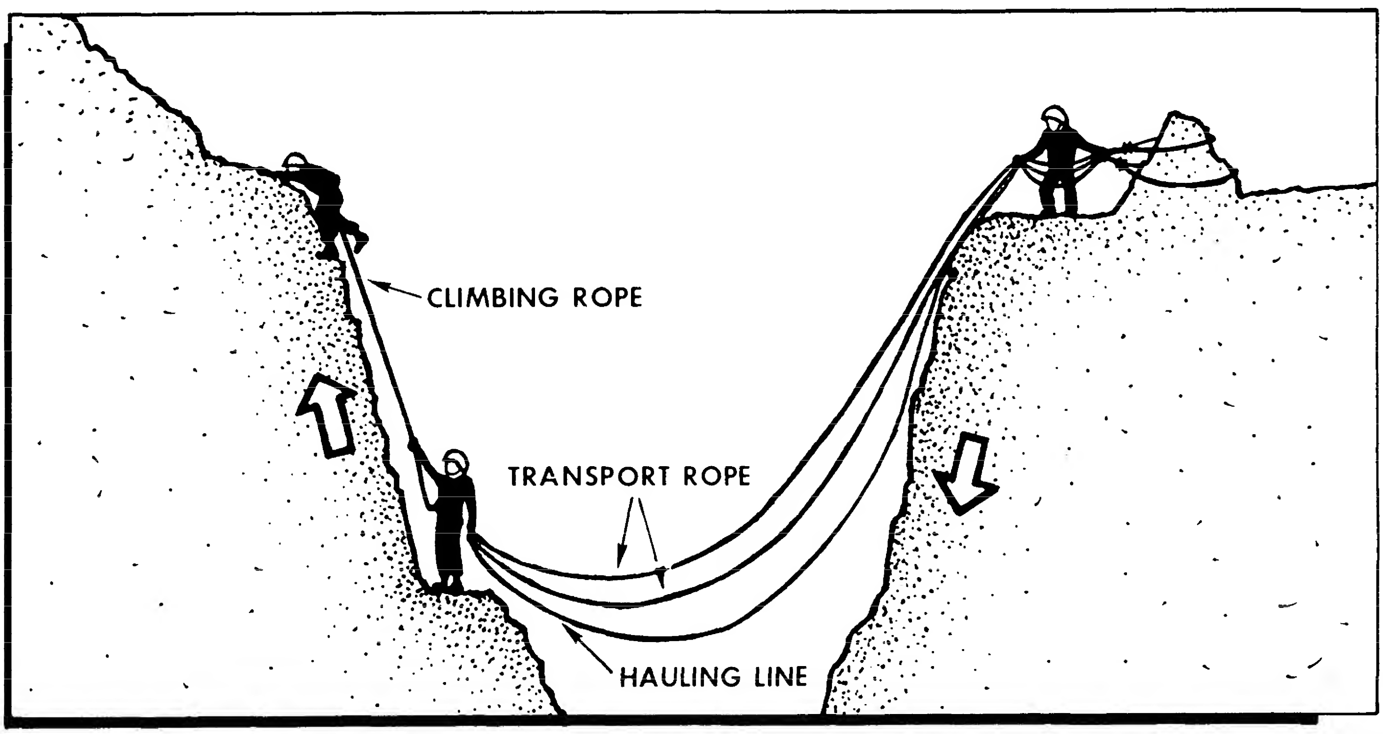


Figure 22-89. Horizontal Hand Evacuation System.

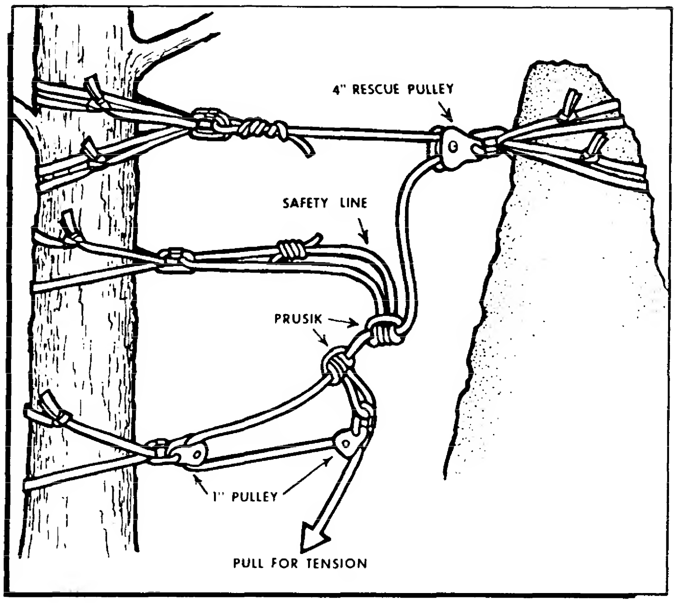


Figure 22-90. Rigging Hand Evacuation System.

to hold the tension on the rope and to slide forward as the slack is pulled out of the rope. The rope is then passed through a carabiner which is attached to an anchor. A smaller prusik sling is tied on the rope behind the first prusik. A carabiner is attached to the prusik sling. The rope is then passed through this carabiner. The rope should resemble a "Z" when the running end is pulled toward the anchor. This is called a "three to one mechanical advantage" because there are three moving lines. The force of pull on the running end of the rope will be increased (ideally) three times. This does not account for the friction of the rope passing over the carabiners or pullies.

(b) Using the mechanical advantage, the following steps should be used to tighten the rope. Pull on the hauling line or the running end of the rope until the snap links come together. Have another person keep this safety prusik slide out as far forward as possible. Then let the safety prusik take up the load, while slowly letting slack out of the running end of the rope. Then slide the second prusik out as far as possible, and repeat the entire maneuver. When the rope is tight enough, tie the rope off (figure 22-90).

(3) Crossing the Two-Rope Bridge. Half the team will now cross the rope by means of the Tyrolean traverse. This is a means of crossing a suspended rope while being secured to the rope. A pulley or carabiner is attached to the rope and clipped into the seat harness. The person then hangs under the rope and pulls hand over hand to the other side. The load is placed on the rope by pulleys or carabiners. The end of the second rope is tied to the load and used to pull the load across the rope to the other side (figure 22-91). Once the patient is secured in the litter, the slings to hold the litter horizontally can be attached. There are six slings in all, one set of three at the foot of the litter. In each of the

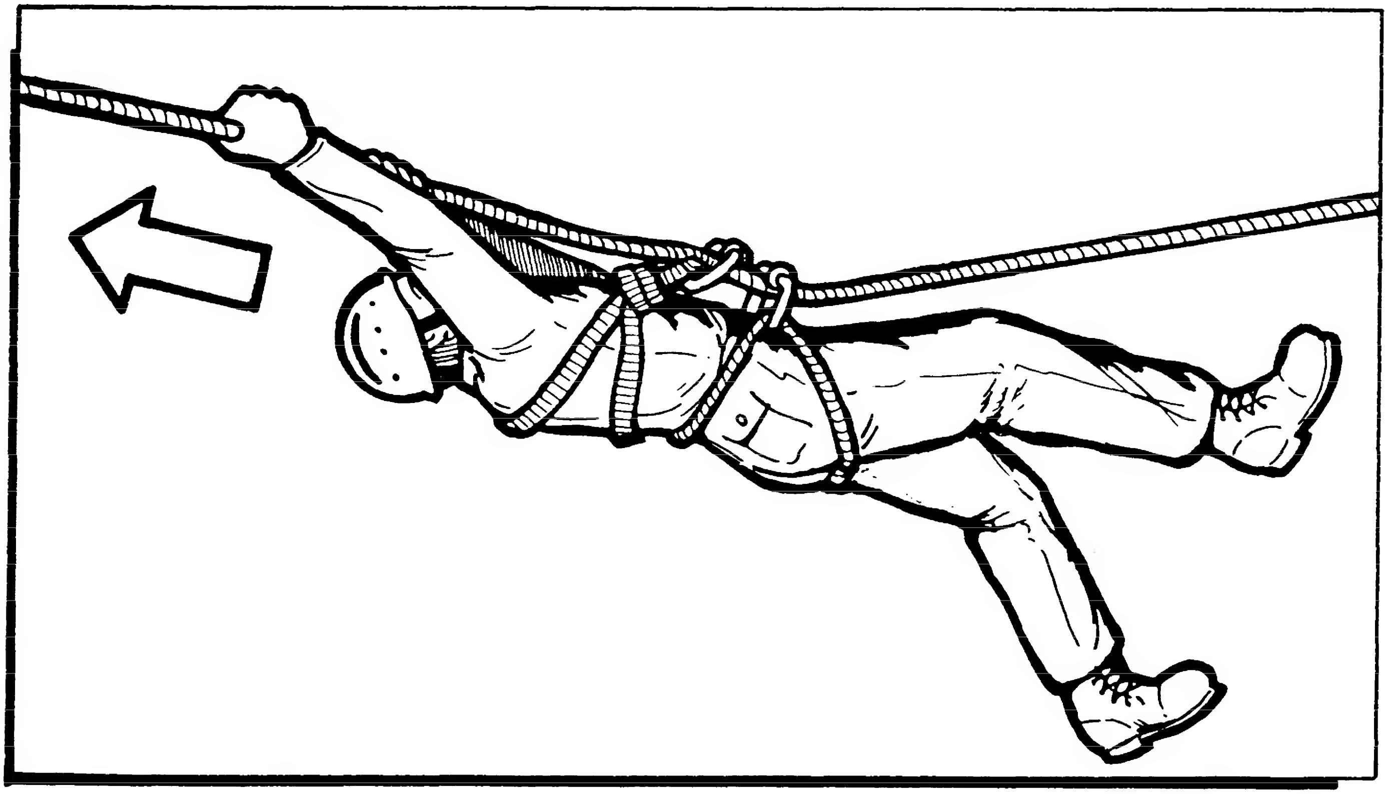


Figure 22-91. Rescuer Traversing.

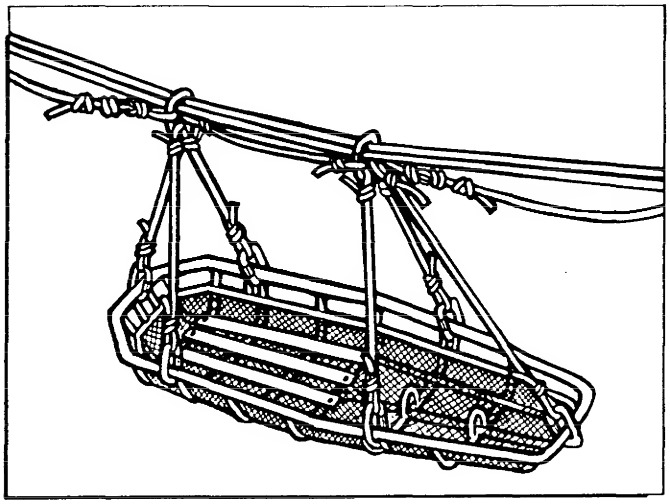


Figure 22-92. Rigging the Horizontal Hauling System.

sets, one is attached to the end of the litter and the other two to the sides of the litter. The slings are about 20 inches long and attached to the inner rail of the Stokes litter with a round turn and two half hitches (figure 22-92). The remaining team then crosses the rope. Each set of slings is attached to a steel "D" locking carabiner. A short length of rope will join the two carabiners for equal pull during the traverse. An in-haul line should be attached to the litter to control the descent or to haul across the open expanse (figure 22-93). To retrieve the rope, the anchors are removed and the rope simply pulled across the obstacle. If an artificial anchor was used for the midrope anchor, it is not retrievable (figure 22-94).

(4) Crevasse or Ravine Recoveries. The ability of a team to recover a victim below them, as in a crevasse, requires the use of a mechanical advantage. A mechanical advantage is the arrangement of ropes and use of pulleys to arrange a system which will allow a force directed on the system to produce a lifting power in multiples of the force. The primary use of a mechanical advantage is to perform vertical lifts as in crevasse or cliff rescue and to apply tension for tightening the system used in construction of hauling lines (figure 22-95). The mechanical advantage can be in different ratios depending on the number of pulleys and changes of direction. Pulleys should be used when a rope passes through a carabiner. If pulleys are not available, a carabiner can be used; however, a larger amount of friction will be present causing a loss of some of the advantage in the system. Rope placement is important in the construction of a mechanical advantage. The ropes should run side by side with no twist around each other. Two basic types are illustrated. The Z-pulley method uses a portion of the load-bearing rope to make the mechanical advantage and, therefore, is a one-rope system (figure 22-96). The second type uses a second rope to establish the mechanical advantage on the load-bearing rope (figure 22-97).

(5) Z-Pulley System. This system of mechanical advantage is used to lift a fallen climber or stranded individual out of a crevasse, up a cliff face, etc. If the fallen climber is attached to a rope, this rope may be used for the system. If the climber is not attached, it will be necessary for a member of the rescue team to rappel or be belayed down to the climber. The rope should be connected to a seat harness and a chest harness. An improvised harness may be required (figure 22-97). Pull all rope slack up from the crevasse. Near the edge, anchor a prusik sling and attach it to the rope. This keeps the rope from slipping back down over the edge.

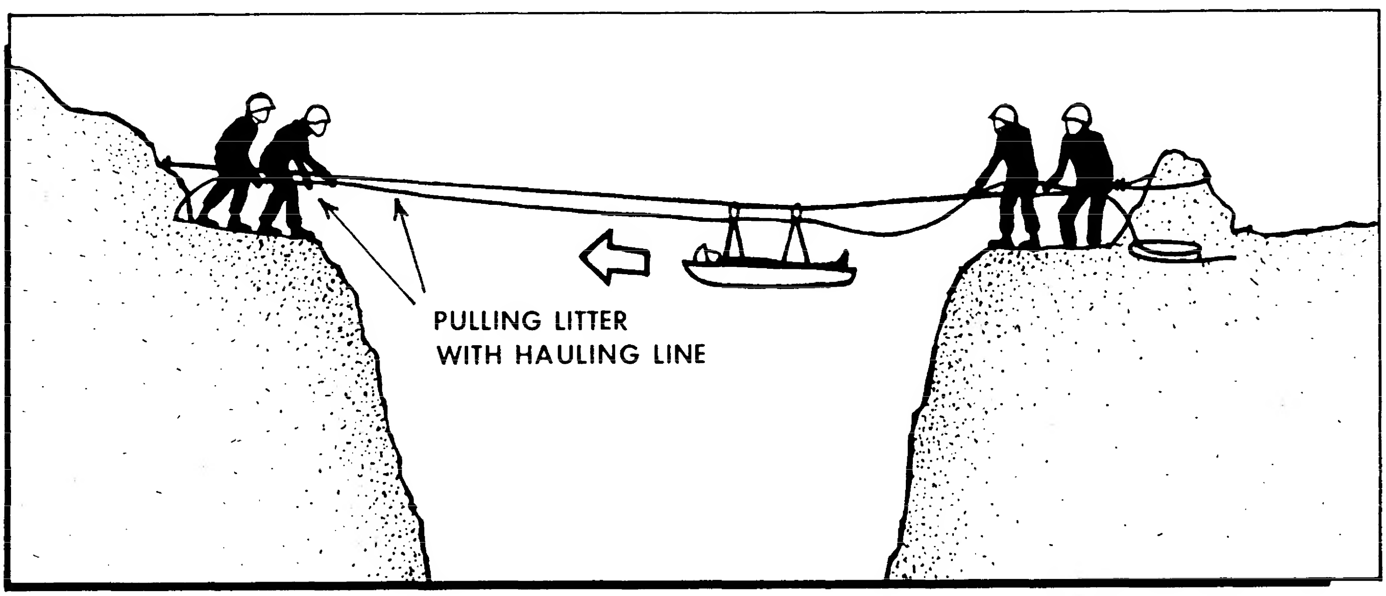


Figure 22-93. Pulling the Litter.

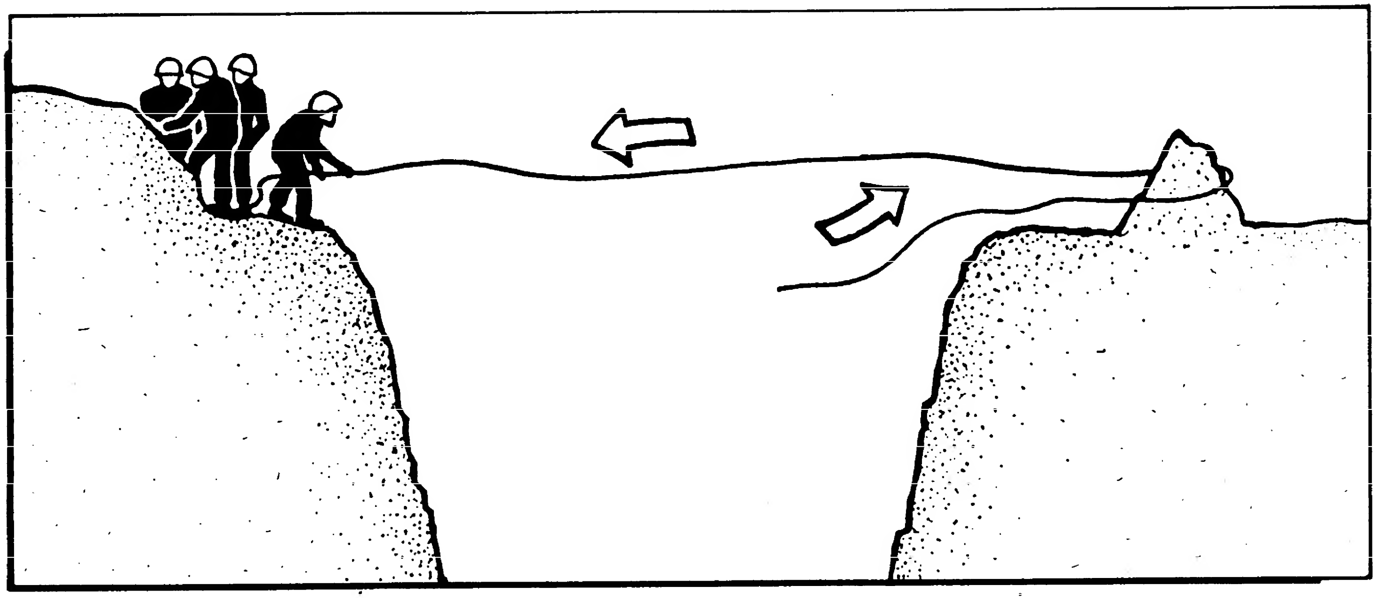


Figure 22-94. Retrieving the Rope.

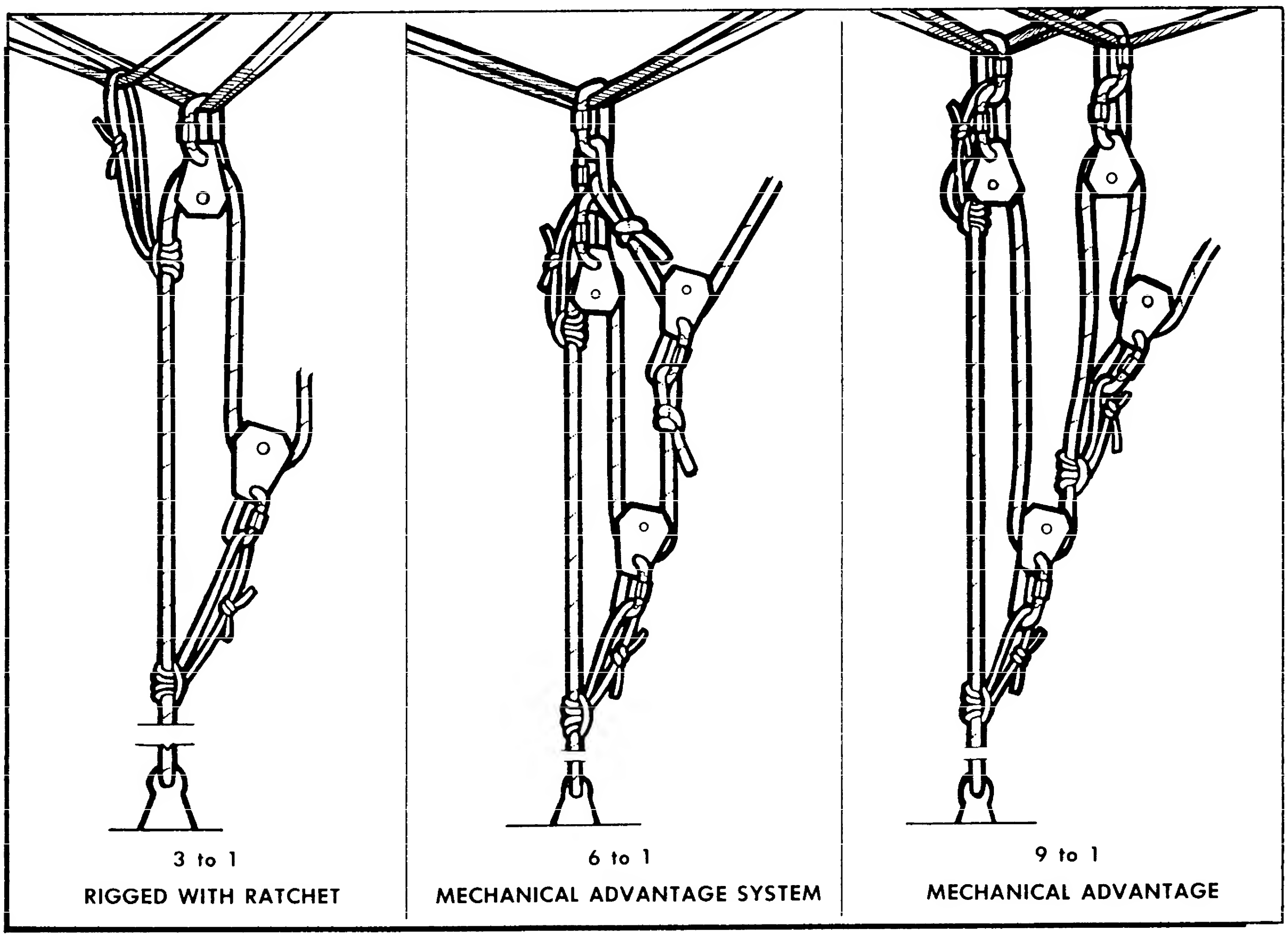


Figure 22-95. Mechanical Advantage Systems.

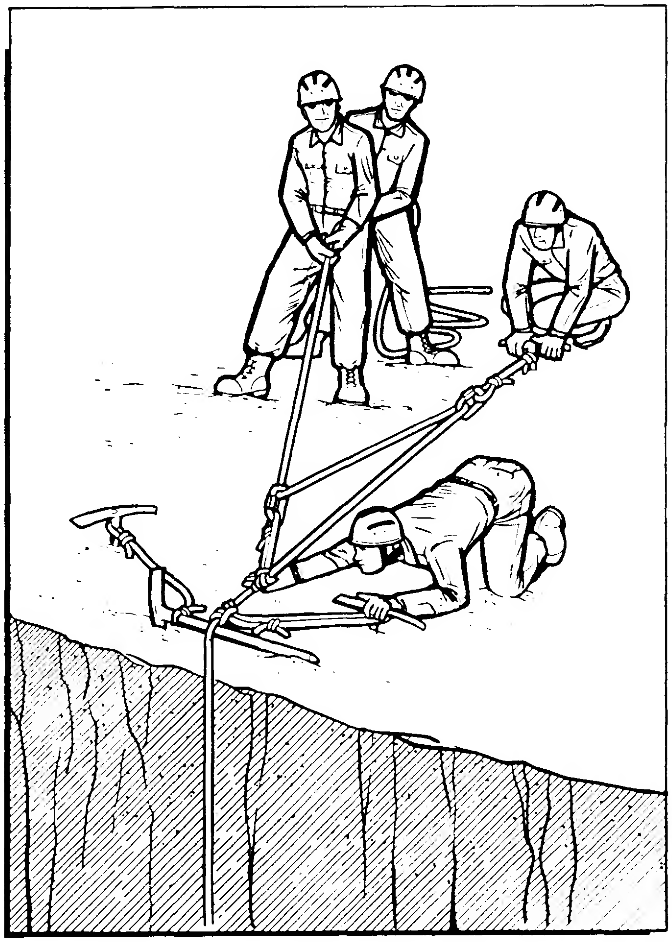


Figure 22-96. Two-Pulley System.

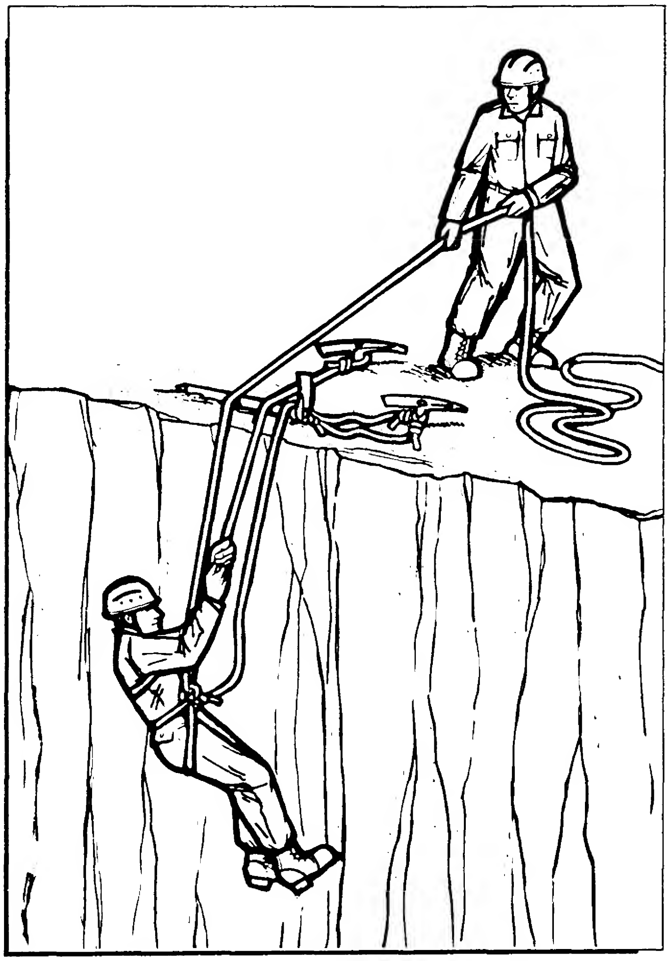


Figure 22-97. Second Rope Added.

An anchor system should be established back from the crevasse and a pulley attached to the anchor. The rope is routed from the crevasse through this pulley. The rope comes out of the pulley and runs back to the crevasse edge. Here another prusik sling is added to the rope as it comes out of the crevasse and a pulley attached to it. The rope from the anchor pulley is passed through this pulley. The system is now complete. The operation is conducted by pulling on the standing end of the rope until the second prusik sling is pulled to the anchor pulley. The prusik at the edge of the crevasse takes the load while the other prusik is reset in the original position. Continue with the lift until the climber is free of the crevasse.

(6) Added Rope Mechanical Advantage. This system requires an additional rope to form the system. As in the Z-pulley system, a rope from the fallen climber is required. Pull all rope slack up from the crevasse. Establish an anchor and connect a prusik sling to the anchor. Secure the belay rope with this prusik sling. Establish two separate anchors and anchor one end of a long sling to the anchor nearest the belay rope. Attach another prusik sling to the belay rope between the anchor prusik and crevasse edge. On the standing end of this sling, attach a carabiner using a figure-eight knot. Attach another carabiner through the body of the figure-eight knot. Place a pulley on each of these carabiners and on the remaining anchor point. Run the long sling through the pulley at the end of the sling, back through the pulley on the second anchor, and through the remaining pulley in the body of the figure-eight knot. The system is ready for operation (figure 22-96). Pull on the long sling end until the prusik with the two carabiners is pulled into the anchor system for the long sling. Allow the anchor prusik to hold the weight and reset the long sling in the initial way. Continue with this procedure until the climber is raised from the crevasse.

(7) Gorge Lift Rescue System. One rescuer rappels to the climber while the other goes around the crevasse or gorge to the other side. An anchor is established on both sides. The end of one rope is thrown across to the far side where it is attached to the anchor. The center of the rope is allowed to drop in the crevasse where the climber is attached to it by a pulley. The end of a second

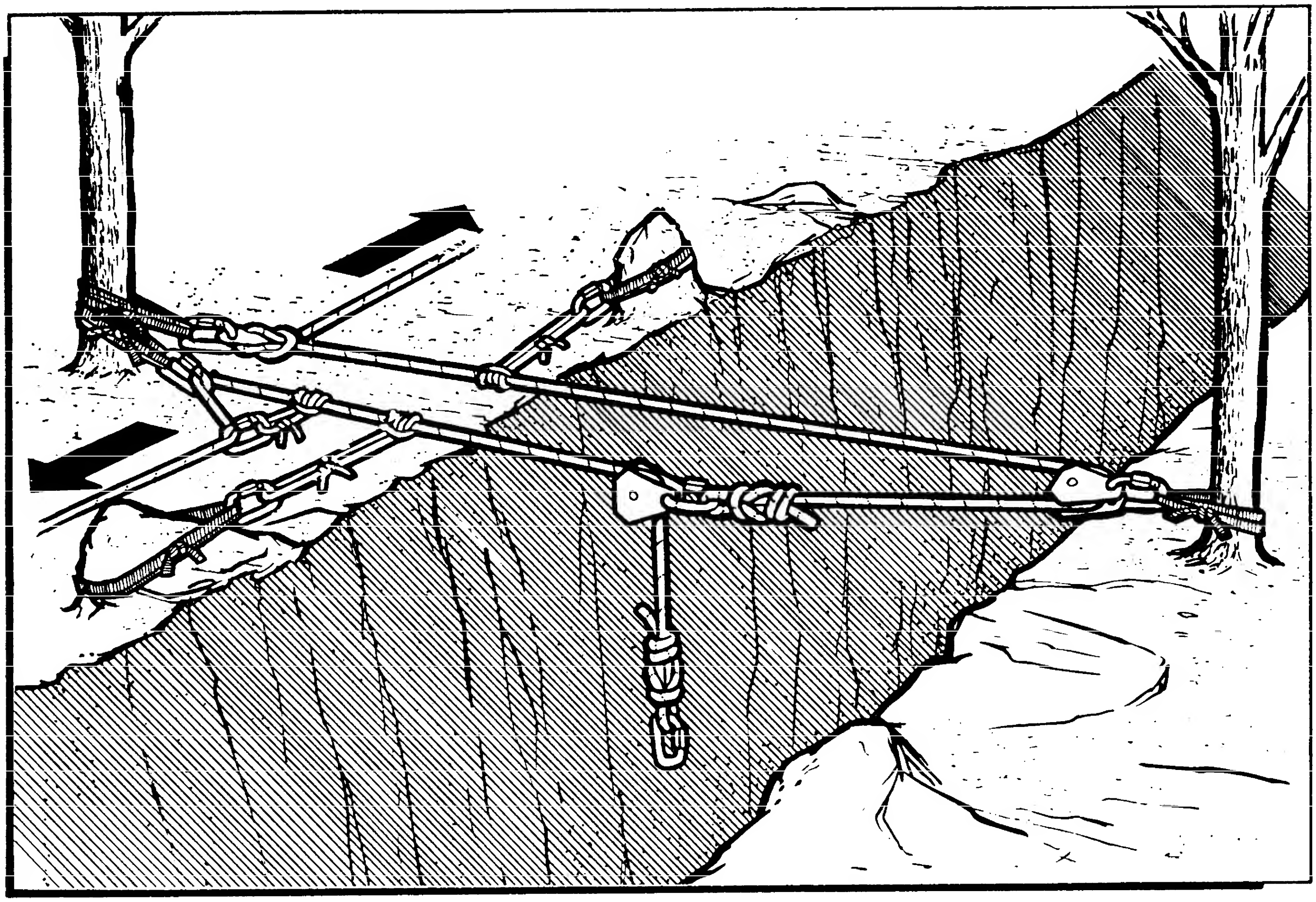


Figure 22-98. George Lift.

rope is lowered to the climber and anchored to the person. The free end of the first rope is put into the mechanical advantage system. As tension is applied to the rope, the climber is lifted. When the rope is at an approximate 40-degree angle, the climber is pulled toward the edge by the ropes. As the climber nears the edge, the weight of the climber will sharpen the angle of the rope. It will be necessary to apply more tension to the rope. Continue until the climber is rescued (figure 22-98).

(8) Rope/Knot Bypass While on Belay. When using multiple ropes or adding extra ropes to a long descent, it is necessary to pass the joining knots through the belay system. The knots will not pass through the system so a method is used which will secure the rope while the belay device is removed and the knot passed. As the knot approaches the belay system, apply a brake and secure the system. Place a prusik sling on the rope below the belay device. Run this sling to the anchor and tie a mariner's knot (figure 22-99). Take the brake off the belay and allow enough rope through the belay until the

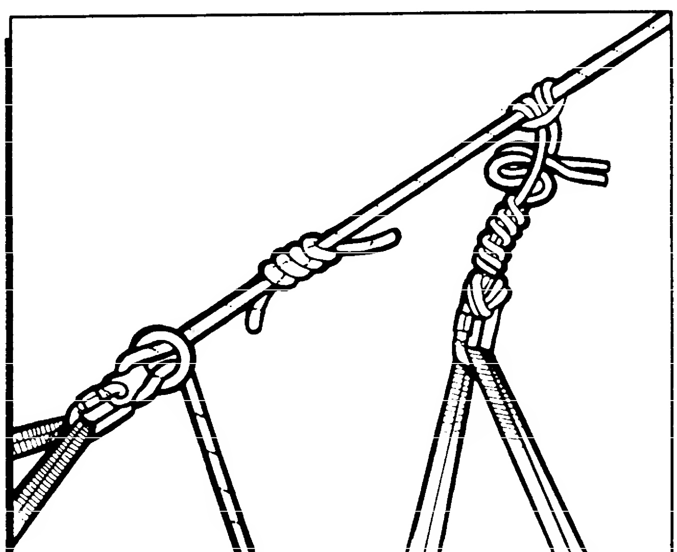


Figure 22-99. Multiple Ropes.

tension is taken by the mariner's knot. Replace the rope through the belay immediately behind the knot and secure the brake. Slowly remove the mariner's knot until the tension is again on the belay system (figure 22-100). Continue with the descent and repeat procedures as necessary.

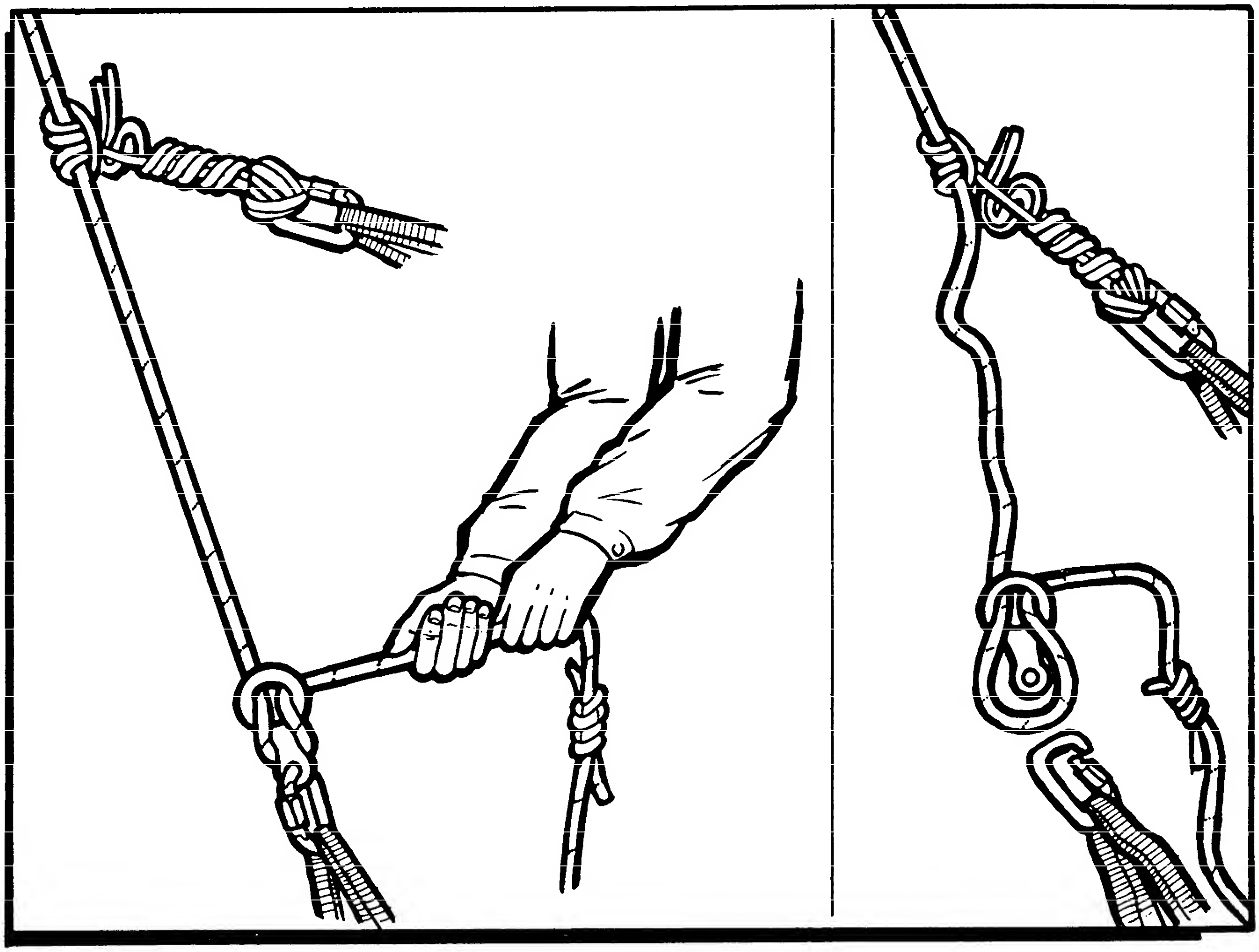


Figure 22-100. Rope Bypass.

Chapter 23

WATER TRAVEL

23-1. Introduction. In this chapter, the travel techniques which can be used on 71 percent of the Earth's surface, the water environment, will be addressed. The techniques of river and open sea travel may be adapted to other water features such as swamps and lakes. In the paragraphs concerning open sea travel, the environmental factors of oceans of the world will be considered as they relate to travel. The techniques for individual water rescue and swimming are important for recovering injured survivors and equipment. Additionally, the problem of submersion must be considered as well as how the antiexposure suit, life preservers, and liferafts can extend a survivor's life expectancy. This is why a survivor must be familiar with the individual rafts and raft procedures. The ultimate goal of a survivor on the open seas is to be rescued; however, a second goal, if rescue is not made, would be to make it to land. A thorough knowledge of water travel techniques will greatly increase the survivor's chances of reaching landfall. If done correctly, landfall can be reached with minimum loss of equipment or injury.

23-2. River Travel:

a. Rivers have been used for centuries in all environments as a safe means of travel and is the reason why most of the cities of the world are located on rivers. It is not uncommon for a river to flow at 4 or 5 knots per hour. A survivor could travel 20 to 25 miles in 5 hours of travel. This may contrast greatly with the rate of travel on land. The amount of energy required to carry survivors' equipment and other supplies and to travel 20 to 25 miles on land is much greater.

b. Each major continent has thousands of miles of navigable rivers. Some rivers such as the Nile, Amazon, Mississippi, Lena, and Mackenzie have hundreds of miles of navigable water with seldom a ripple. These navigable sections are generally found flowing through the flatlands, plains, tundras, and basins of the world. In these areas, only the temperatures of the water and the plant and animal life may present hazards. In contrast, the headwaters of rivers, like the Mackenzie, Yangtze, and Ganges, are so rough that they would best be categorized as a threat to life. This would also be true of the Snake, Salmon, and Rogue Rivers of the Northwestern United States. These rivers, although traveled by white water rafters, pose an unreasonable hazard to survivors. Survivors must take into account individual or group skills, injuries, type and severity of rapids, the temperature of the water, and direction the river flows in making the decision to travel. Even if a portage of several miles is required, the energy saved by floating on a river might warrant river travel. However, once the energy expended for portage exceeds the energy conserved by floating a section of a river, the river as a mode of travel should be abandoned.

c. In a nontactical situation, rivers will most likely carry survivors to indigenous people who could aid the survivor in meeting the basic needs for sustaining life and effecting rescue. Even if some form of civilization is not encountered, the survivors would most likely reach a lakeshore or even the seacoast. These environments, particularly the seacoast, provide transition zones from land to water which are rich in food and other survival resources. In these areas, the resources could improve the chances of survival. It is much easier to spot signs of survivors along a shore versus the interior of a landmass.

23-3. Using Safe Judgment and Rules for River Travel:

a. There are certain safety rules and guidelines that must be followed to reduce the dangers associated with river travel. Respect for these rules and guidelines is necessary to reduce the potential dangers.

b. The most important safety rule is personal preparation. Preparation should begin by thoroughly scouting the river. The conditions of the river will determine the intermittent stops. High ridges along river edges provide needed visibility to plan each leg of travel. If there are numerous bends and poor lookout points to view the river, stops are frequent. Sound judgment must be used when planning routes. Patience in planning each leg of travel helps prevent disaster. All survivors must prevents know the plans and be able to handle the route safely, considering their skills and strength. Survivors should be aware of and avoid river hazards and have alternate routes and communication signals in case flow conditions suddenly change, making the run more difficult. All rapids which cannot be seen clearly from the river should be scouted. The route should be discussed with the crew. The skills, knowledge, and abilities of the aircrew members must be considered, including swimming abilities and physical condition. Areas of high risk should not be attempted. Before reaching an area of suspected great difficulty, rafts should be beached and carried to the next point of travel; this is called portaging.

c. Before entering the raft, survivors should don life preservers and suitable clothing for adequate protection. The equipment should be tested to ensure it is serviceable. Bulkiness is not advisable due to the possibility of the raft capsizing and being weighted down with water. The antiexposure suit (if available) should be worn. Items that might absorb water should be packed in a waterproof container. The survivor should ensure that:

(1) All medical supplies, repair kit, and survival kit are in the raft.

(2) Survival kit is checked and inventoried.

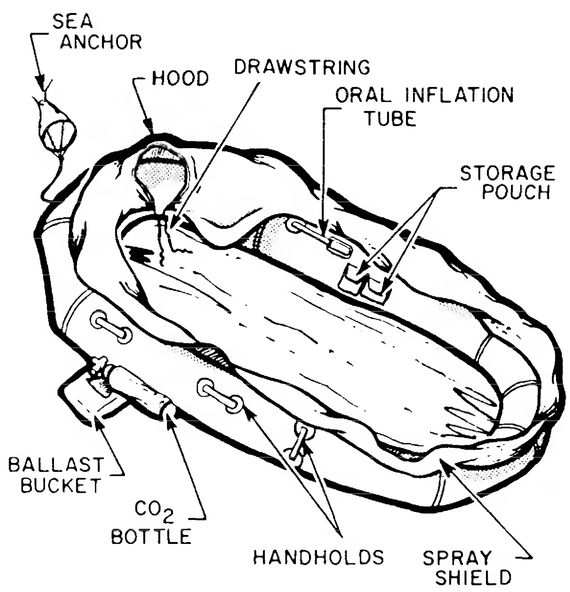


Figure 23-1. One-Man Raft.

(3) Extra efforts should be made to keep supplies and equipment in good condition.

(4) All items are secured to the raft to prevent loss and (or) injuries.

(5) Before use, the raft is checked for leaks and necessary repairs are made.

d. When using a one-man raft for river travel (figure 23-1), it may be advisable to tie or cut off the ballast bucket, fasten the spray shield in the opened position, and remove the sea anchor to prevent problems with swamping or entanglement with subsurface obstacles. Without the ballast bucket, the raft can be easily maneuvered by paddling with the backstroke or for slight adjustment, with a front stroke. When using either the backstroke or the front stroke, the survivor will find it easier if the two underarm cells of the life preserver underarms (LPU) are disconnected in front and the cells placed behind the back (figure 23-2A). This gives the survivor a full range of motion. When rough water is encountered, the survivors should fasten the LPU and face downstream.

e. One of the primary methods of avoiding hazards on the river is to slow the speed of the raft and move across the river, avoiding a collision with the obstacle. This ferry position should be initiated early to avoid large rocks and reversals in the river. If the collision obstacles are to be avoided, point the bow of the raft toward them and backstroke against the current to slow the speed of the raft's downstream progress and move it across the river. Usually, the best angle is about 45 degrees to the current. The greater the angle, the quicker the movement across the river, but this also increases the downstream speed of the raft. Decreasing the angle will slow downstream speed, but movement across the width of the river will also be decreased (figure 23-2B). The raft will be more maneuverable if it is well inflated. If the raft should pass over a rock, arch the back up to prevent injury to the buttocks or back.

f. When using multiplace rafts, the boarding ladder and sea anchor should be removed to prevent entanglement. If available, about 50 feet of line should be tied on the bow and stern of the raft to be used for tie-offs. An additional 200 feet of line should be coiled and tucked away for emergency and rescue work; one end is secured to the raft while the other end has a fixed loop. An improvised suspension line rope may be used for this; for example, three-strand braid can support about 1,000 to 1,500 pounds of pressure, or a two-strand twist strengthens the line to support about 700 to 900 pounds of pressure (figure 23-3).

g. Proper placement of equipment and personnel should equalize weight distribution to ensure stable control; overloading should be avoided. Assign personnel crew positions and responsibilities in the raft; captain (person in charge), stern paddler (maneuvers raft), and side paddlers. Twilight and night rafting should be avoided (nontactical) as poor visibility increases danger.

h. Two ways to steer a multiplace raft are:

(1) To steer a raft by using sweeps (long oar) and poles. A pole is more efficient in fairly shallow water, but a sweep is preferable in deep water. Poles and sweeps from both ends of the raft are used. The person in the bow (front) can see any obstructions ahead, and the one in the stern (rear) can follow directions for steering. Poles are also useful for pushing a raft in quiet water.

(2) Paddle techniques are used to maneuver the raft. When paddling, there are three possible body positions on a raft. The best way is to sit on the upper buoyancy tube with both legs angled to the inside of the raft. The body should be perpendicular to the sides of the raft, enabling the rafter to paddle. Another way is to sit cowboy style, straddling the upper bouyancy tube of the raft with one leg on either side, and folding at the knee with each leg back. However, the outside knee may collide with obstacles and cause injury. The third way is normally used in calmer waters because it consists of partially straddling the upper tube, with legs comfortably extended. In a smaller raft, the survivor may be able to sit down inside the raft and reach over the buoyancy tube. The following strokes can be done from these positions. Knowing the parts of paddles will help in explaining the different paddling strokes (figure 23-4).

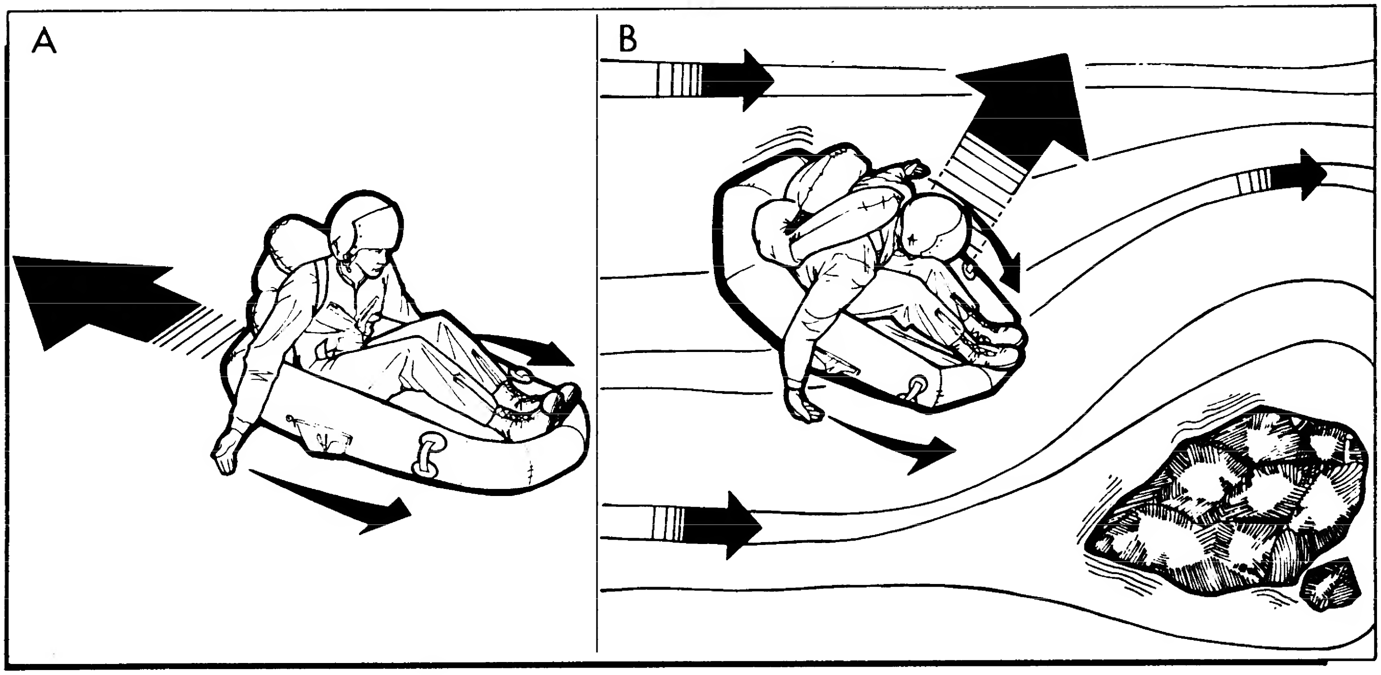


Figure 23-2. One-Man Raft (Paddling).

(a) One of the easiest is the forward stroke which is done in smooth continuous movements using these techniques:

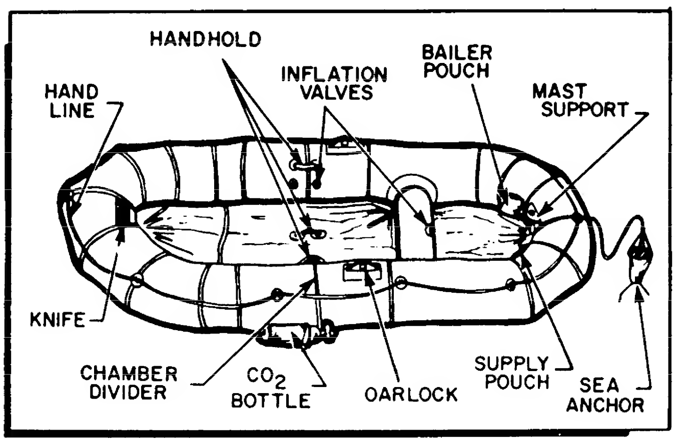


Figure 23-3. Seven-Man Raft.

-1. Thrust the blade of the paddle forward using the outboard arm, then momentarily keeping the outboard arm stiff and away from the raft, push the grip. The inboard hand is then moved forward to cut the blade deeply into the water. Continue the stroke by pushing on the grip and pulling on the shaft keeping the blade at a 90-degree angle to the raft. Stop the motion as the blade comes slightly past the hip, because a full followthrough provides little forward power and wastes valuable energy. Slide the blade out of the water by pushing down on the grip and swinging it toward the inboard hip and turning the blade at a parallel angle to the water once it has cleared the water. By paralleling

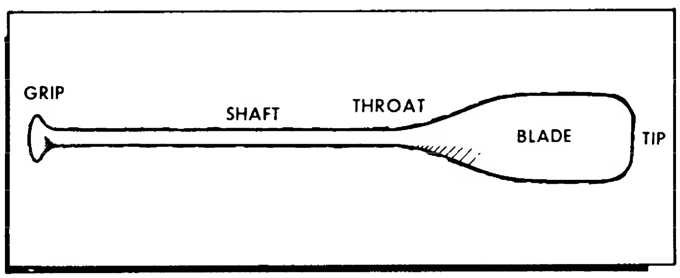


Figure 23-4. Paddle.

the blade, it cuts wind and wave resistance and saves time and energy. This cycle is repeated until the strokes are changed.

-2. In mild water, there is no need to over reach or excessively twist the upper trunk of the body. When extra speed is needed, lean deeply into the strokes which brings the entire body into play. Position the inboard hand across the tip of the paddle grip and the outboard hand halfway to three-fourths of the way down the shaft.

(b) The opposite of the forward stroke is the backward stroke. The blade is thrust into the water just behind the hip, and pressure applied by simultaneously pushing forward on the shaft and pulling back on the grip. End the stroke where the forward stroke would

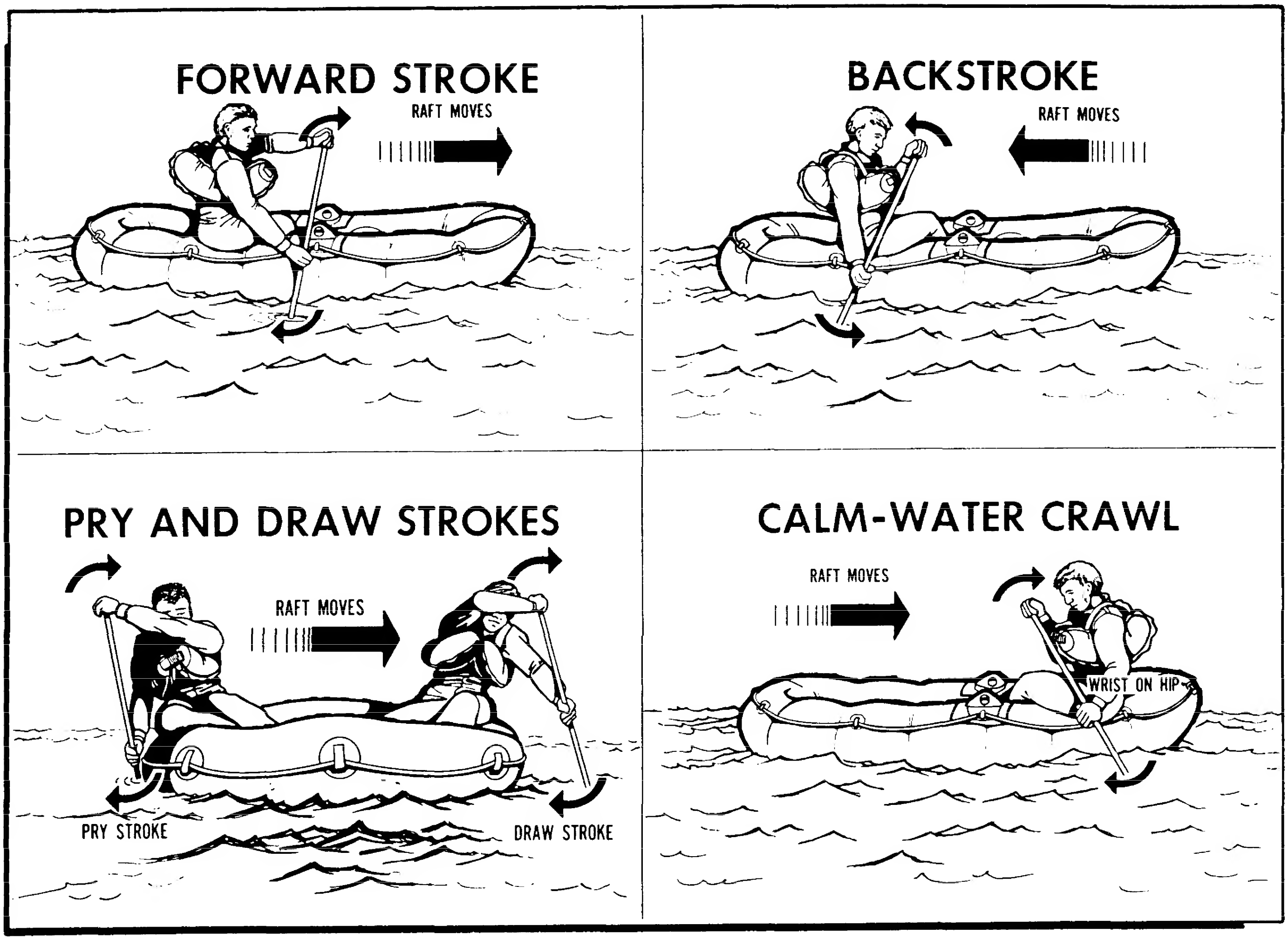


Figure 23-5. The Paddle Strokes.

begin, and again angle the blade out of the water back to the beginning of the backward stroke.

(c) The draw and pry strokes are opposite sideways strokes. These strokes are good for small sideways maneuvers and for turning the raft when used from the front or rear of the raft.

-1. Drawstroke. Reach out from the raft, dip the blade in parallel to the raft, and pull on the shaft while pushing on the grip. Pull the blade flat to the side of the raft. Pull the paddle out and repeat.

-2. Pry stroke. Dip the blade in close to the raft, and push out on the shaft while pulling in on the grip.

(d) The fifth stroke, called the calm water crawl, is used alternately with the forward stroke when paddling through long calms. Sit cowboy fashion while facing the stern and hold the paddle diagonally in front with the shaft which is held by the outboard hand against the outboard hip and the grip held by the inboard hand in front of the inboard shoulder. Extend the inboard arm to swing the blade behind, dip the blade in the water, and pull back on the grip, prying it forcefully, using the hip as a fulcrum (the point of support on which a lever works). Using the shoulder, hip, and hand as assisters, the crawl is easy yet powerful (figure 23-5).

(e) The ferry is a basic paddle maneuvering technique used to navigate bends and to sidestep obstacles in swift currents. The ferry is essentially paddling upstream at an angle to move the raft sideways in the current. Paddle rafts can ferry either with the bow (front) angled upstream or downstream. The bow-upstream ferry is stronger because it uses the more powerful and easier forward stroke. It is carried out by placing the raft at a 45-degree angle to the current with the bow angled upstream and the side toward the desired direction. The bow-downstream ferry is weaker because it uses the less powerful backstroke, but it does offer certain advantages. It enables paddlers to look ahead without straining their necks, and makes it easy to put the bow into waves (figures 23-6 and 23-7). It is carried out

by backstroking with the stern (back) angled upstream at a 45-degree angle and the side facing the desired direction.

(f) There may be times when the only way for a heavy raft to enter a small or violent eddy is with a reverse ferry (figure 23-8). The following steps may be used for an oar or paddle raft, except the paddle raft approaches the eddy bow first and finishes in a bow-upstream position:

-1. Raft approaches sideways.

-2. Raft turns around to angle its bow downstream.

-3. With careful timing, the captain should have the crew begin to pull powerfully on the paddle. The angle of the raft to the current can be close to 90 degrees, but is best at about 45 degrees.

-4. While aiming for the eddy, the crew should continue with the front stroke and gain momentum.

-5. With the crew still using the front stroke, the raft breaks through the eddy fence.

-6. With the bow in the upstream eddy current and the stern still in the downstream current, the raft is spun into a normal ferry angle. The crew continues with the front stroke while making the necessary turn to bring the boat entirely into the eddy.

-7. The raft rides easily in the eddy. (NOTE: The reverse ferry and eddy turns are not only used to enter eddies, but can also be used to dodge through tight places. The reverse ferry (or sometimes an extreme ferry) scoots the raft sideways, the eddy turn snaps the bow into a bow-downstream position, and the raft, rather than entering the eddy, rides the eddy fence past a major obstruction or hole.)

(g) The straight forward paddle is used in calm and moderate waters where there is ample maneuvering time. Simply point the bow in the desired direction and follow the forward stroke method of paddling. The back paddle is performed the exact opposite of the forward paddle. Point the stern (back) in the desired direction and follow the backstroke method of paddling (figure 23-5).

(h) To make a left turn, the left side of the raft will backpaddle, while the right side paddles forward. It's just the opposite to make the raft turn right. The right side on the raft backpaddles while the left side paddles forward—both performing the paddling maneuvers at the same time (figure 23-9).

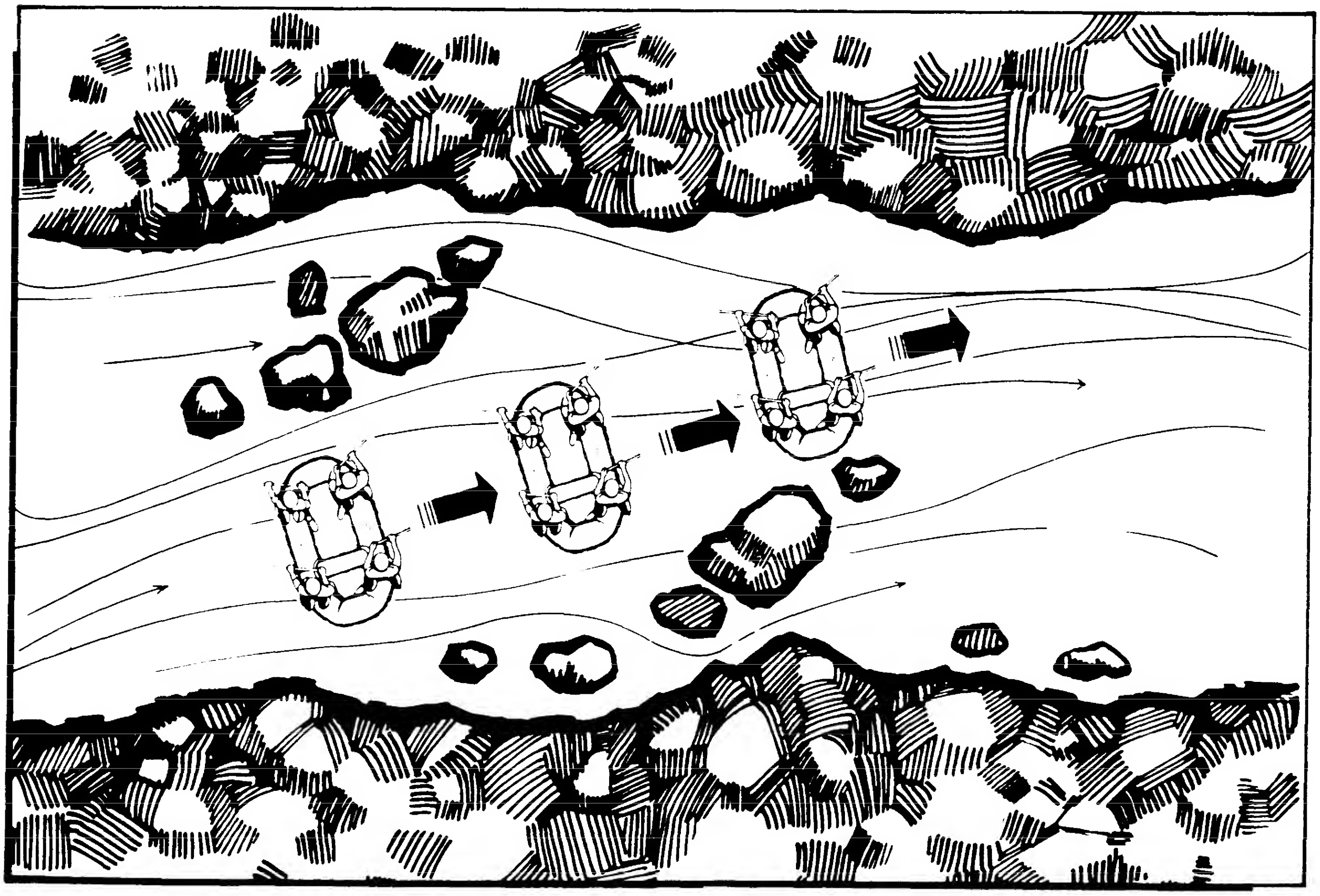


Figure 23-6. The Paddle Ferry.

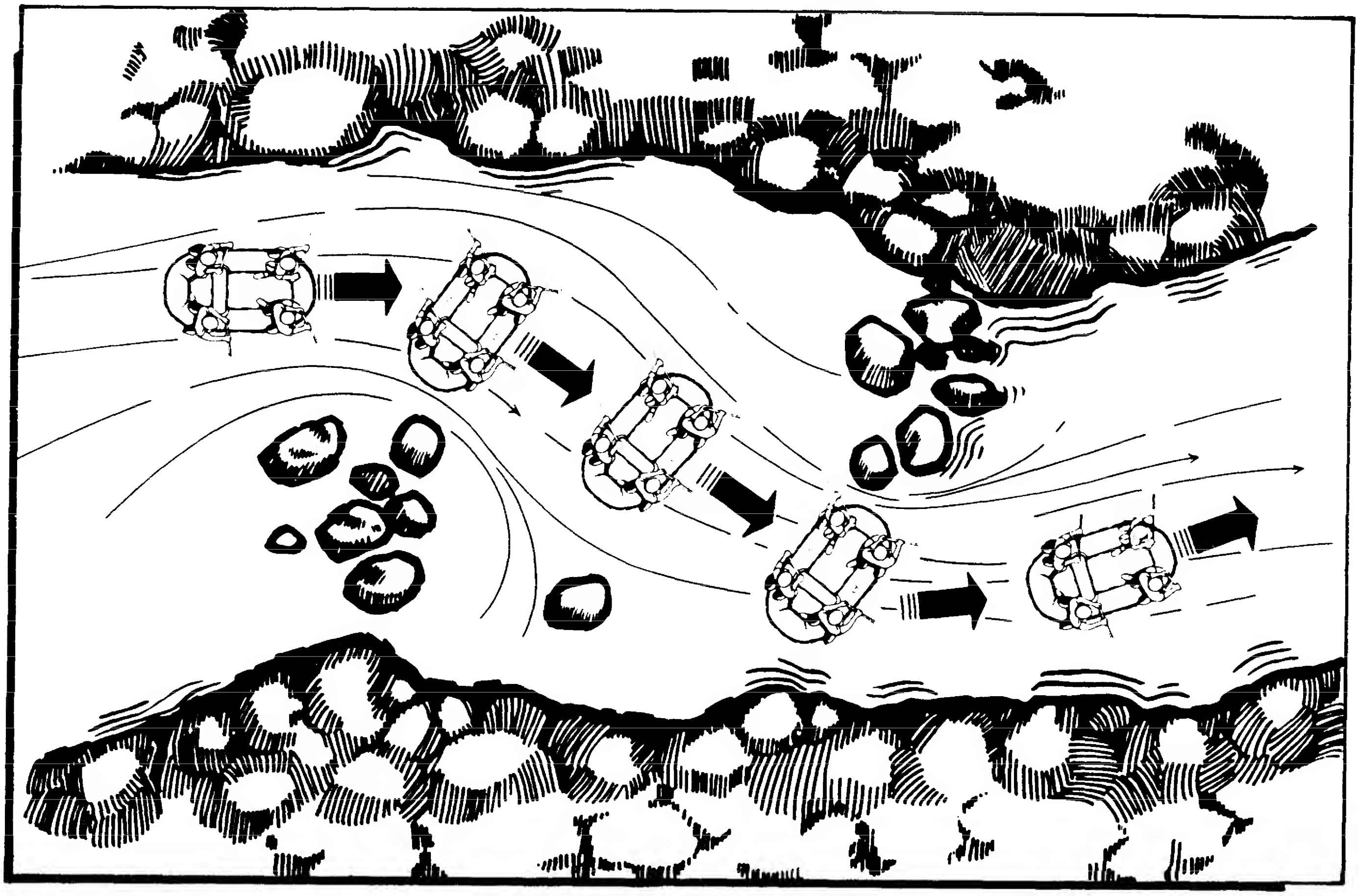


Figure 23-7. Bow Downstream Ferry.

(i) The pry and draw strokes are used to move the raft sideways (figure 23-10).

(j) Stern maneuvers are used to increase the maneuverability of the raft. The paddle used at the stern of the boat is basically a rudder which controls direction. To turn right, the paddle blade is held to the right, square against the direction of the current. To turn left, the paddle is held to the left.

(k) Other strokes, such as a forward stroke or draw stroke, used at the stern of the raft, will cause it to turn or move faster. If stroking is done slightly to the side (either right or left) of the raft, it will help move the raft in the opposite direction (figure 23-11).

(l) River travel requires fast, decisive action. Therefore, a paddle raft needs a captain to coordinate the crew's actions by the use of commands or signals. Communications between captain and crew are crucial; all members must agree on a set of short, clear commands. The following are suggested commands:

CAPTAIN'S COMMANDS:	CREW RESPONSE:
Forward	Crew paddles forward.
Backpaddle	Crew does backstroke.
Turn right	Left side paddles forward, right side does the backstroke.
Turn left	Right side paddles forward, left side does the backstroke.
Draw right	Right side uses draw stroke, left side uses pry stroke.
Draw left	Left side uses draw stroke, right side uses pry stroke.
Stop	Paddlers relax.

-1. Commands must be carried out immediately, so the crews should practice until they can snap through all the commands without hesitation. The captain controls both the direction and speed of the raft with a specific tone of voice and commands. This control, and the captain's ability to anticipate how the water ahead will affect the raft, will help avoid undercompensation and overcompensation of maneuvers through obstacles. Good captains think well ahead and

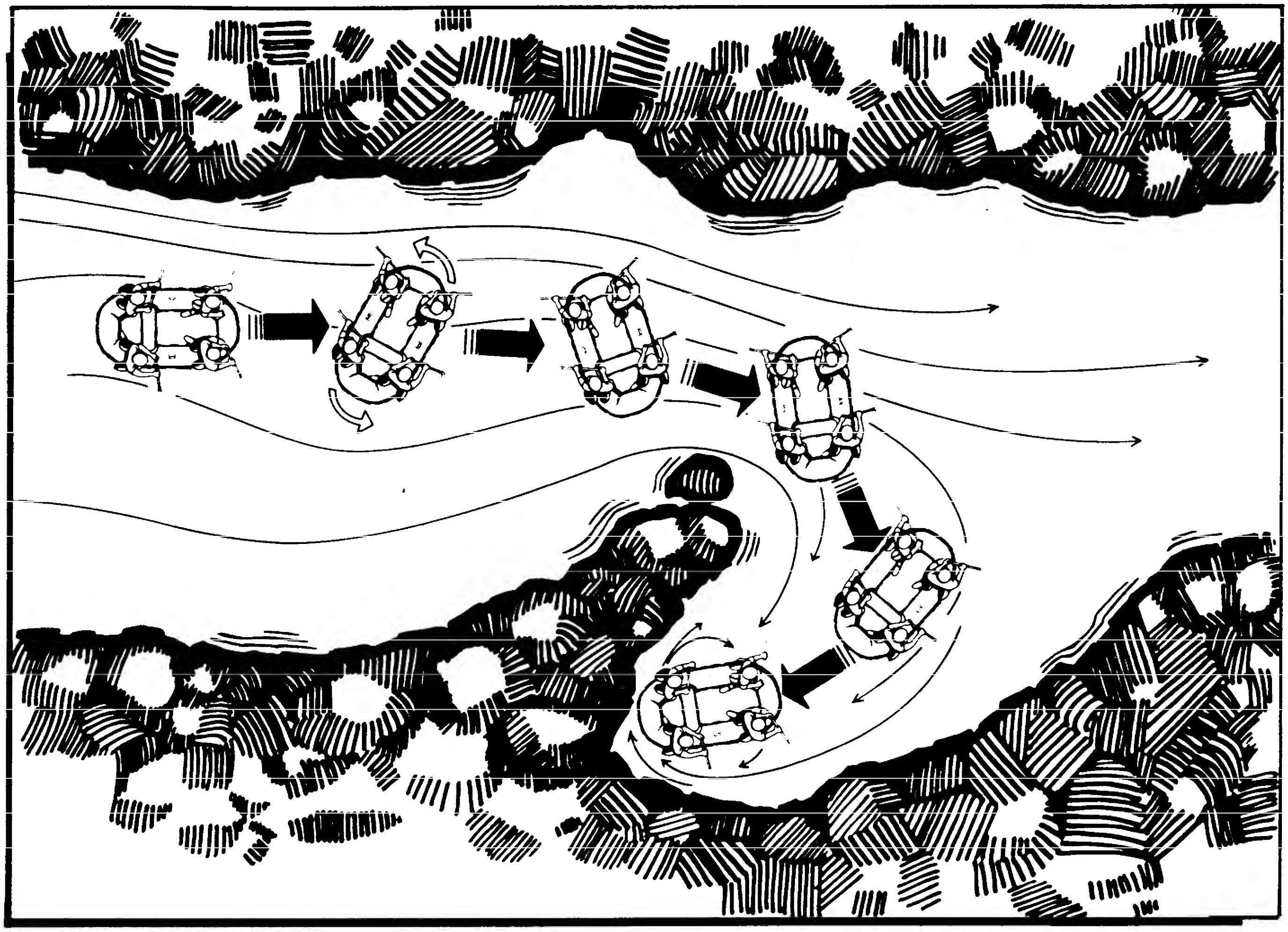


Figure 23-8. Entering an Eddy with a Reverse Ferry.

move with the river, issuing commands precisely and sparingly, working their crews as little as possible.

-2. When using commands and maneuvering the boat in harmony with the river's currents, paddling can be easy and effective, even fun. When instant action is necessary, the captain may say, "paddle at will." When time permits, the captain should introduce commands with a preparatory statement such as, "we're going to ferry to the right of that big rock. OK—(gives command)." This gives the crew time to prepare for the next response. If a command is not heard or understood, it should be repeated with zest until it is understood. If a raft member spots a better way through a rapid or channel, a fully extended arm is used to point it out. This signal, like the others agreed upon, should be repeated until it is understood.

23-4. River Hydraulics. An understanding of river hydraulics is important to the survivor. A knowledge of the types of obstacles and why they should be avoided or overcome is necessary for a safe river journey.

a. Laminar Flow. The drag produced when moving water flows over or past various types of objects and surfaces is called a laminar flow (figure 23-12). The laminar flow principle is that various layers or channels of water move at different speeds. The lower layer of the river moves more slowly than the top layer. This is due to the friction on the bottom and sides of the river which is caused by soil, vegetation, or contours of the riverbank. The layers next to the bottom and sides are the slowest; each subsequent layer will increase in speed. The top layer of the river is only affected by the air. The fastest part of the flow on smooth straight stretches of water will be between 5 and 15 percent of the river depth below the surface. Even straight running riverbeds are not smooth; they have jutting and receding banks on the sides which affect the laminar flow. The friction caused by the banks causes the sides of the flow to be slower than the midstream. The areas near the banks are more shallow and have fewer layers. When the river travels at 4 to 5 knots, turbulence begins to develop which interferes with the regular flow of the current. When this rate of riverflow is achieved, the

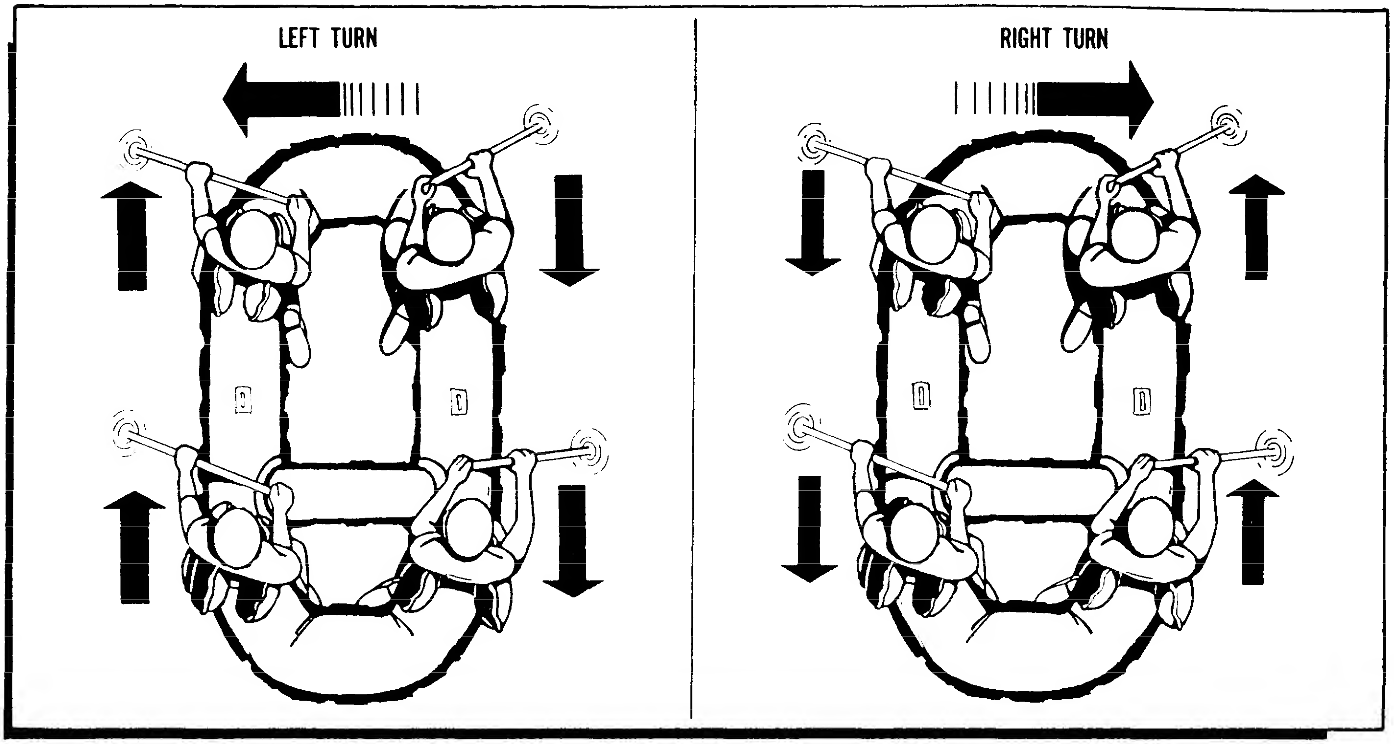


Figure 23-9. Turning the Raft to the Right or Left.

friction between the layers of water will cause whirling and spinning actions which agitates the smooth flow of water, creating more resistance.

b. River Currents:

(1) When a current of a river is deflected by obstructions, the overall downward flow of a river will

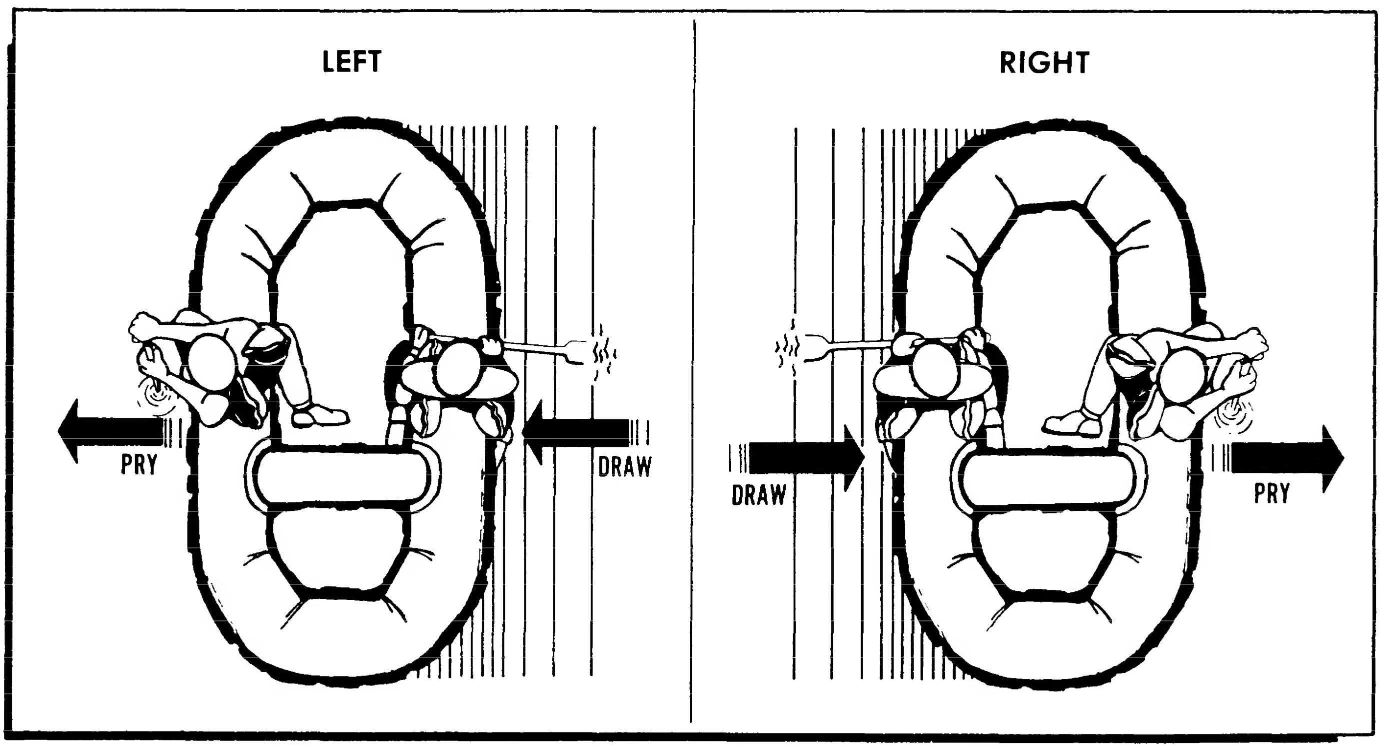


Figure 23-10. Making the Raft Move Left or Right with Pry and Draw Stroke.

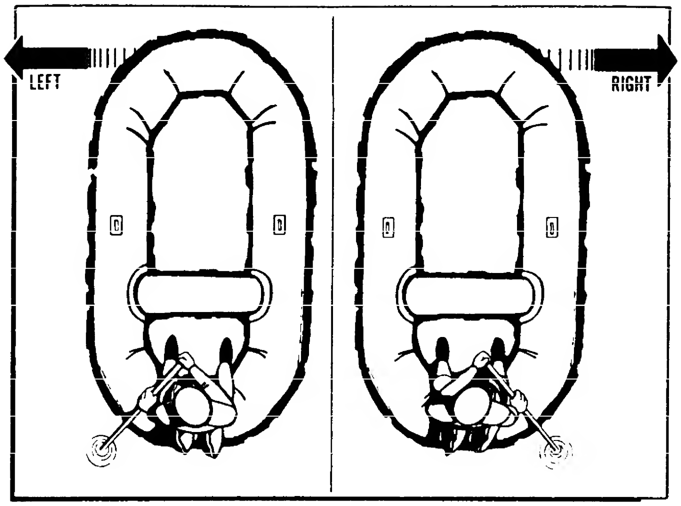


Figure 23-11. Stern Maneuvers.

respond. These responses vary from mild to radical deflection, creating direction and speed changes of waterflow. These changes are called reflex current. The reflex current responds to an obstruction such as bends or submerged rocks.

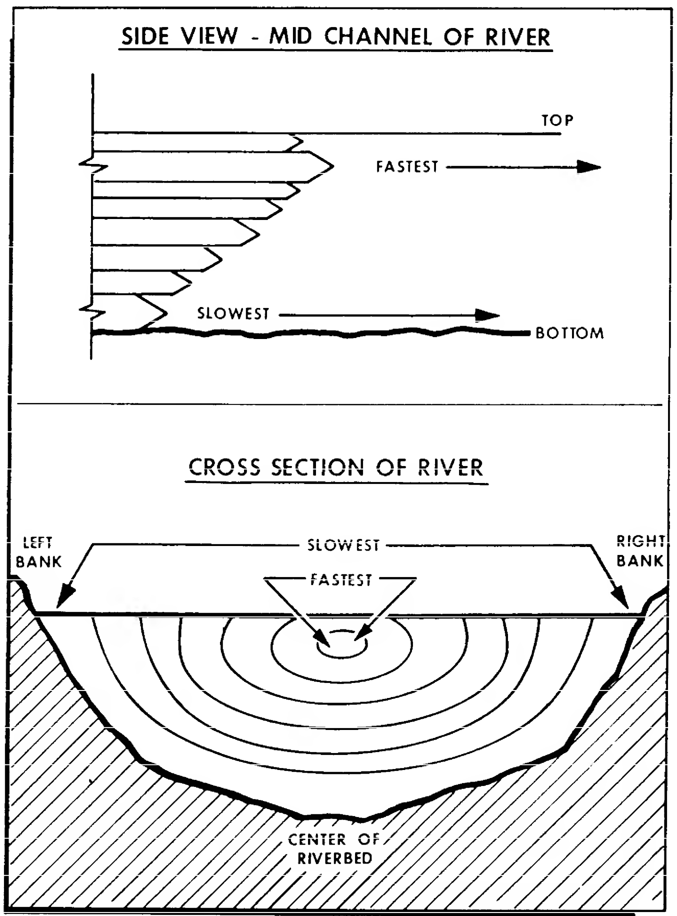


Figure 23-12. Laminar Flow.

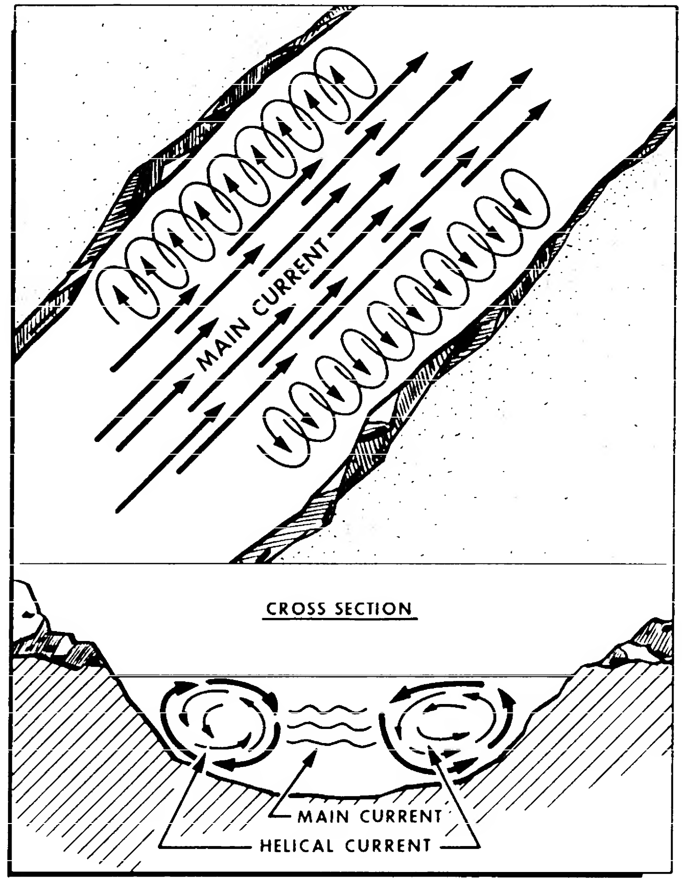


Figure 23-13. Helical Flow.

(2) One response to the laminar flow is a spiraling, coil-springing flow called a helical current (figure 23-13) which corkscrews as a result of the friction with the riverbank. Going downriver, on the left side of the supposed straight-line river, the helical flow turns clockwise to the main current, and on the right side the helical flow is counterclockwise. This results from friction and drag caused by shallowing banks combined with the strong force of the main current flowing down. The helical flow and the mainstream create a circular, whirling secondary current which travels down along a line near the point of maximum flow. Helical current flow starts along the bottom of the river going out toward the riverbank, surfacing, and then spiraling back into the mainstream at a downward angle. This flow causes floating objects around the edges to be pulled into the mainstream and held there. By understanding where the fast water is and how to observe the characteristics which show the current, a survivor can maneuver the raft to take advantage of the faster water to increase the rate of travel. Even at the quietest edge of a flow, particles are still drawn into the strongest part of the current. Laminar and helical flows are always present in fast-flowing rivers.

(3) The main channel is the deepest part of the river and can wander from bank to bank. The turbulence

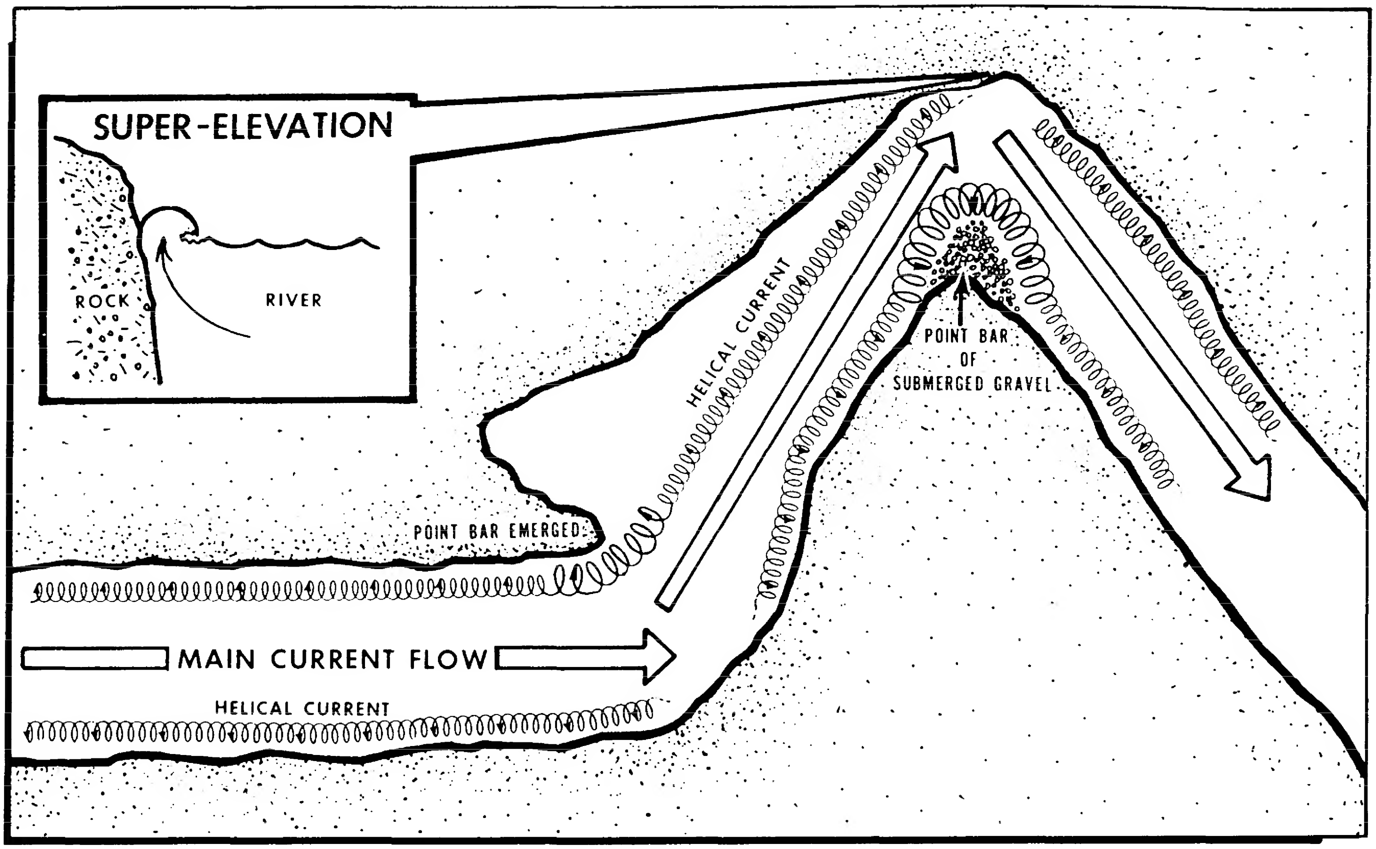


Figure 23-14. Macroturbulence.

caused by the wandering main current erodes wide curves into sharper, more defined bends, creating indirect courses.

(4) When the river makes sharp turns, the current is affected by centrifugal force swinging it wide into the outside bank. The helical current diminishes, being smothered by the laminal flow, thereby increasing the corkscrew effect on the inside of the curve. The surface water is being whirled hard in the direction of the outside curve of the bank; the faster the waterflow, the stronger the push. Floating objects are forced, with the surface water, to the outside of the curve and into the banks, usually getting lodged against and onto the shore.

(a) A powerful helical flow not only pushes the surface outward, but as it swirls up from the bottom it carries sediment up with it. The sediment and other debris is deposited at the highest point of the inside bank of the bend. The sediment is then dropped during high water, and when the water recedes, a point bar (made of sand and gravel) is revealed. The point bar generally sticks out far enough to funnel floating objects into the swiftest part of the river during high waters, avoiding the sandbar.

(b) Super-elevation is a feature where the water is being increased in volume, intensity, and height. When both the stream volume and movement are high, centrifugal force exerts another type of influence on flow characteristics. The river surface water tends to curve in a dish shape towards the outer bend, like a banked turn on a racetrack. The dished inside curve is the easiest and safest route to travel through. If maneuvered correctly, the slight rise of the water and the force of the current around the curve will cause the raft to slip gently off the wave and into the quiet pools of water below. But if the raft was maneuvered across the line of the currents, the raft may either be sucked under by the dominant helical flow, or the power and force of the river on the outside of the dish on the curve could smash and pin any floating device against the outside bank.

(5) Macroturbulence is any extreme, unpredictable turbulence (figure 23-14). It is an especially dangerous phenomenon caused by a drop or decline in the river bottom. The phenomenon also occurs when the water comes in contact with the river bend or rocks. The extreme amounts of froth created from the turbulence and the gravitational pull cause rafts to spin. Raft control is extremely limited because the lack of water viscosity causes resistance against paddles and a lack of buoyancy, making it difficult to float or maneuver. This type of

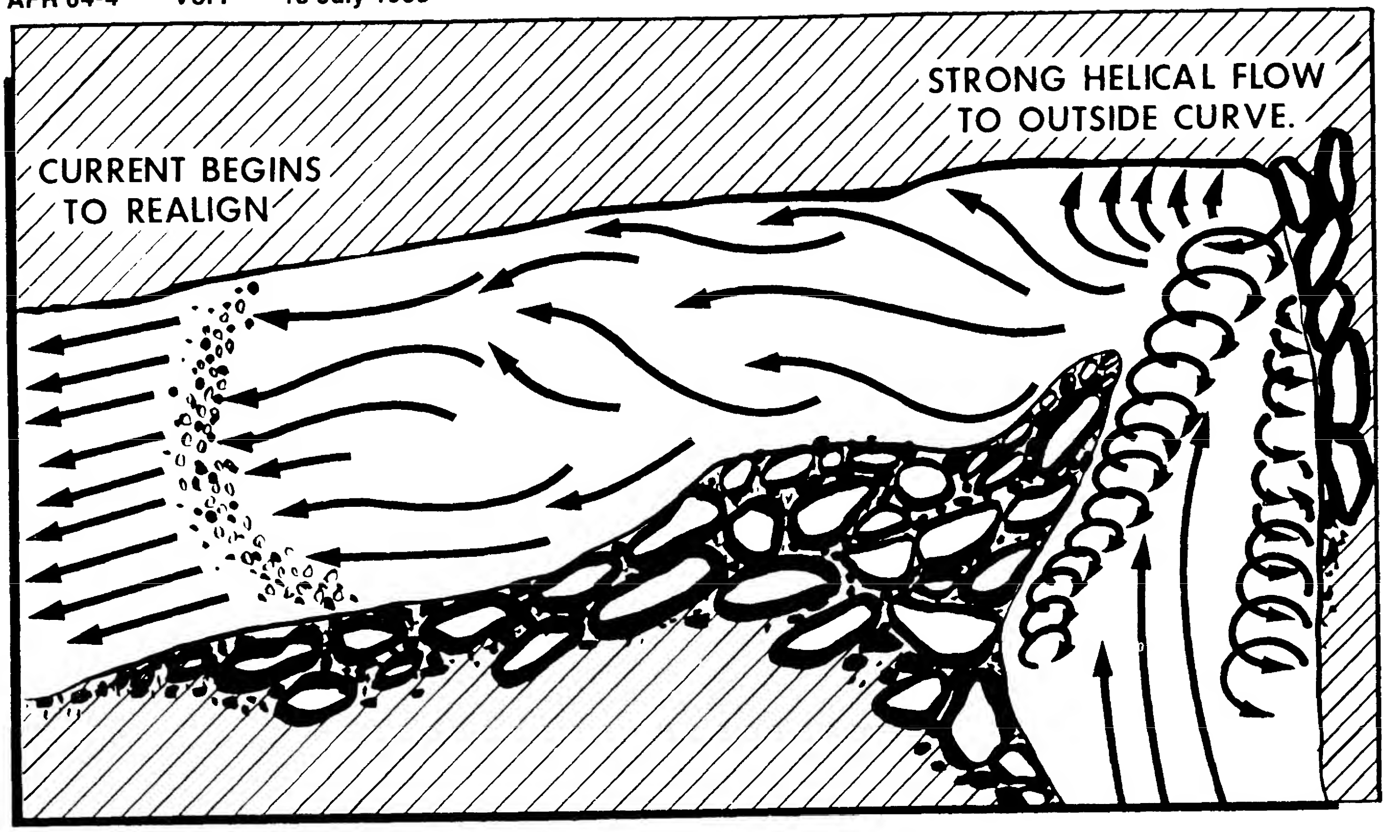


Figure 23-15. Anatomy of a River Bend.

white water can be impassable, depending upon how extreme the dip and amount of waterflow.

(6) Coming out of a sharp bend, the river currents are mixed, but the dangerous movement is still pulling. The result of the laminar flow shooting into a bank creates a helical flow effect immediately below the turn, where the river is still trying to assume a natural "straight" flow. Being a liquid, water cannot resist stress and it responds to a variety of obstacles (most common are submerged boulders) (figure 23-15).

(7) When water flows over obstructions, such as submerged boulders, the character of the laminar flow is changed. As the water flows over the top of the rock, the layers of the laminar flow increase in speed. This is known as a venturi effect. The hydraulic area is a type of "vacuum" formed as water flows around the rock. Created directly below the obstruction are confused and disordered currents which accelerate the layers of the laminar flow (figure 23-16).

(8) One type of hydraulic is the surge, which usually occurs when the current is slow and the water is deep. This hydraulic is formed downstream from an obstruction with a surge in the water volume. When obstacles no longer have the ability to hold the water back, the pressure is released. Surges present few problems if the boulder or obstruction is covered with enough waterflow to prevent contact when floating over the top. Survivors should be aware of obstructions (known as "sleepers") if the water does not sufficiently cover them (figure 23-17). Failing to recognize a sleeper can result in raft destruction and severe bodily injuries. With large sleepers, the water flows over the top creating a powerful current. This powerful, secondary current is trying to fill the vacuum created by the hydraulic downstream action.

(9) Another form of large sleeper is referred to as a dribbling fall. These are caused by minimal water flowing over submerged obstacles with considerable drop below. This type of sleeper causes a bumpy ride, reducing speed, and can capsize the raft.

(10) Breaking holes occur where a large quantity of water flows over a sleeper and the drop is not steep enough to create a suction hole (figure 23-18). A wave of standing water, much like an ocean breaker, is found downstream. This wave is stationary and can vary from 1 to 10 feet high, and even though it lacks the strong upriver flow of a suction hole, it can be a trap for rafts too small to climb up and over the crest. The size of the breaking hole and the survivor's seamanship must be considered before tackling this obstacle.

c. Suction Hole or Three-Dimensional Eddy:

(1) The vacuum created by a suction hole is strong enough to pull a survivor wearing a life preserver be-

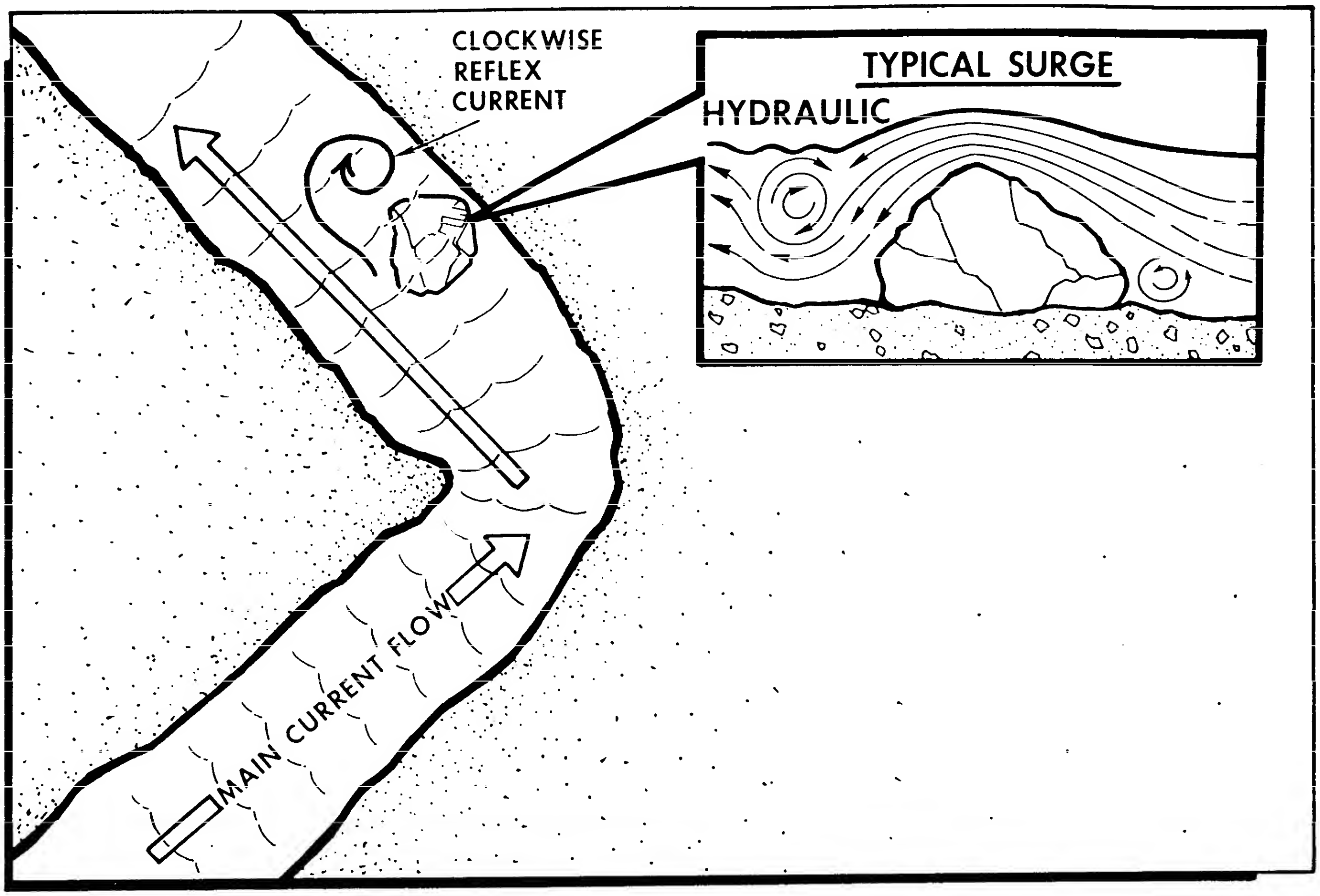


Figure 23-16. Response to a Submerged Rock.

neath the surface. If pulled down into a suction hole, the survivor will normally be whirled to the surface downriver and returned to the suction hole by the upriver flow, to be pushed under once again. Objects too buoyant to sink normally remain trapped. It's usually difficult to identify a suction hole because there is no frothing, no obvious curling water, and little noise. Extreme caution should be used when a large bulge appears in the water (figure 23-19). There are three possible ways of surviving and avoiding serious injury in suction holes. One way is to find the layer of water below the surface which is moving in the same desired direction. The second way is to reach down with a paddle or hand and feel for a current which is moving out of the hole. However, in a large suction hole the downstream flow will be too deep to reach. The survivor should attempt to cut across through the side of the eddy into the water rushing by. The final and best solution is to scout ahead and try to identify the location of suction holes and avoid them.

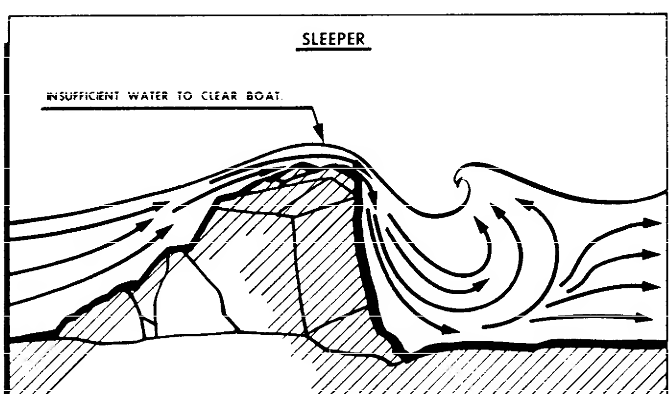


Figure 23-17. Sleeper.

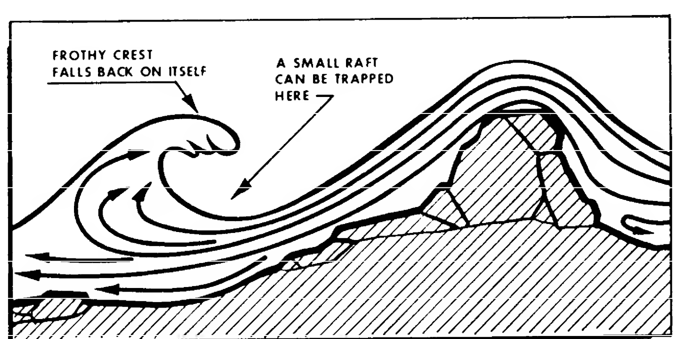


Figure 23-18. Breaking Hole.

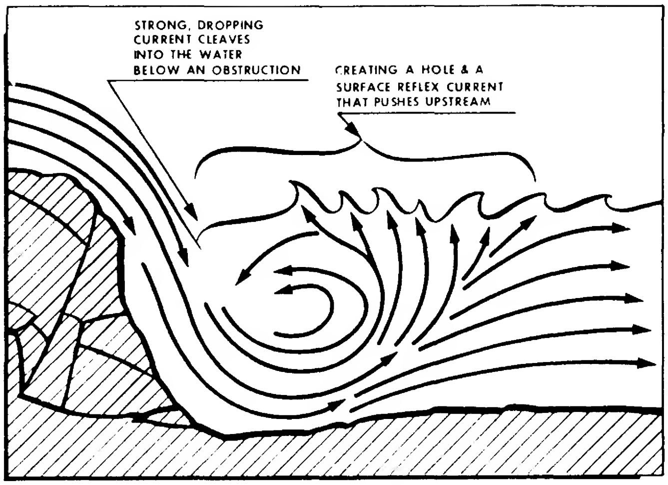


Figure 23-19. Suction Hole.

(2) An eddy (figure 23-20) is a reaction to an obstruction. The type of eddy which occurs next to the bank is caused by portions of the main current being deflected and forced to flow back upriver where it again joins the mainstream. These areas are usually associated with quiet and slow-flowing water. They are also associated with areas where the river widens or just above or below a bend in the river. An eddy has two distinct currents: the upstream current, and the downstream current. The dividing line between the two is called an eddy fence. It is a line of small whirlpools spun off the upriver current by the power of the downstream current.

(3) A two-dimensional eddy is when the tip of an obstruction is slightly above the water and causes a two-dimensional flow around the obstacle. Because of the speed and power of the current, the water is super-elevated and is significantly higher than the level of water directly behind the obstacle. This creates a hole which is filled by the flow of water around the obstacle (figure 23-21). Two-dimensional eddies which occur in midstream will create two eddy fences, one on each side of the obstacle. The water will enter the depression from both sides and will travel in a circular motion, clockwise from the right bank, counterclockwise from the left bank, and back upstream directly behind the obstacle. If the projection is large enough and a strong circular motion is created, it becomes a whirlpool. The outer reaches of the swirling water are super-elevated by centrifugal force and a suction is created, similar to a drain in a bathtub. These vortexes are very rare and usually occur on huge rivers. Survivors may stop and rest where the eddies occur since there should be no strong swift currents in the eddy. If the obstacle is huge, it may be impossible to paddle fast enough to cross the eddy fence without being spun around in a pinwheeling manner.

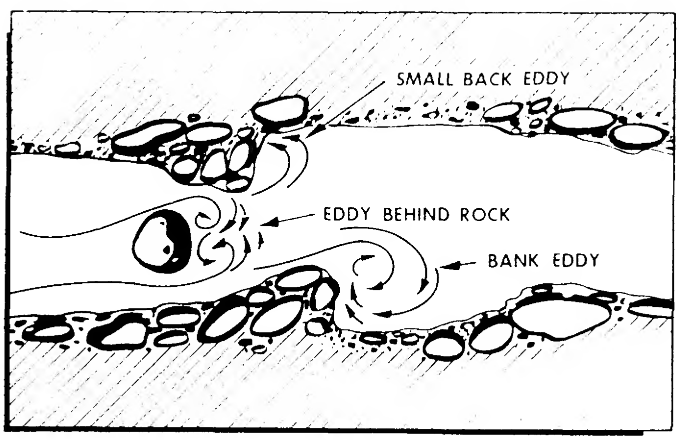


Figure 23-20. Eddies.

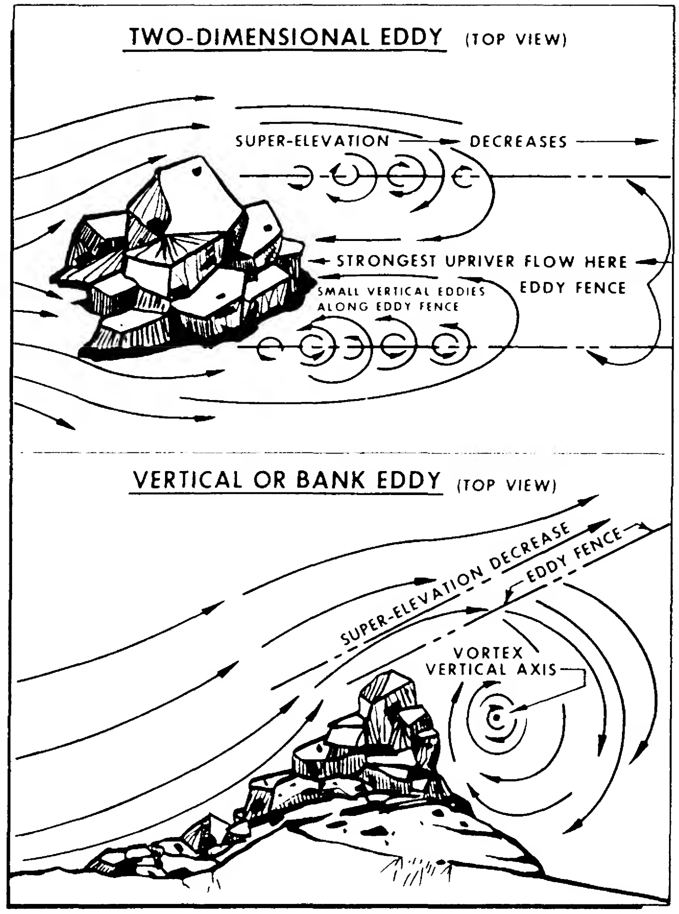


Figure 23-21. Two-Dimensional Eddies.

d. Falls. In most falls, there are two reflex currents or suction holes forming, both whirling on crosscurrent axes into the falls (figure 23-22). One current falls behind the crashing main stream of water while the other falls in front. It's not too dangerous on a 2- or 3-foot drop, but when heights of 6 or more feet are present, it could be a death trap. The suction holes formed below these falls are inherently inescapable because of their power. The foam and froth formed at the bottom of falls

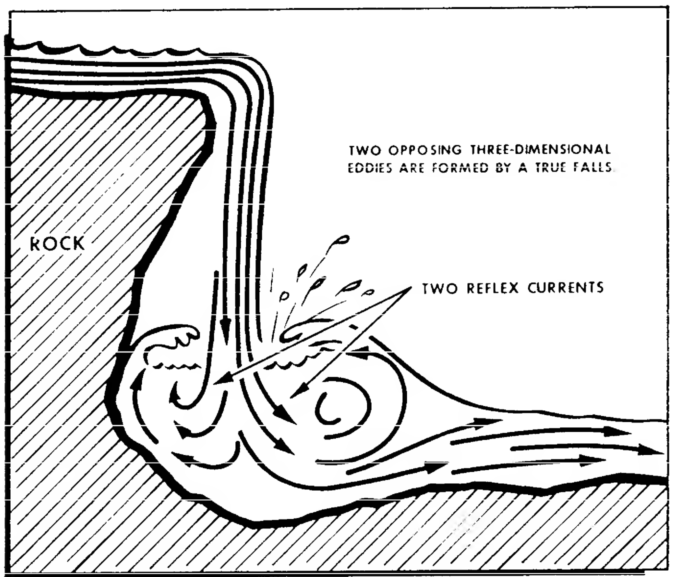


Figure 23-22. Falls.

can be dangerous. Jagged boulders and other hazards may be hidden.

e. Boils. A boil may occur below a fall or sleeper, downstream of the curling or reverse-current suction. This appears as a dome or mound-shaped water formation. Boils are the result of layers of flows hitting bottom, aimed upward, and reaching the surface parting into a flowerlike flow. The water billowing out in boils is super-oxygenated, taking away the resistance needed to push with the paddles or to suspend a survivor in a life preserver.

f. Rollers. Another difficulty found when traveling on fast rivers are rollers. Rollers are large, cresting waves caused by a variety of situations. A wave seen below a breaking hole is one type of roller. Velocity waves are another type which occur on straight stretches of fast dropping waters and caused by the drag of sandy banks and submerged sandbars. They may be large enough to overturn a raft, but are easily recognized, and are usually regular and easy to navigate by keeping the raft direction of travel in line with the crest of the wave (figure 23-23).

g. Tail Waves. Tail waves are quiet waves which are a reflex from the current hitting small rocks along the bed of the river and deflecting the current toward the surface. They are usually so calm that going over them is not noticeable.

h. Bank Rollers. Bank rollers are similar in appearance to crested tail waves and occur when there is a sharp bend in the riverbed which turns so sharply the water can't readily turn in the bend. The water slams into the outside bank and super-elevates, falling back upon itself. Small bank rollers cause few problems, but large ones cresting 5 feet or higher can capsize a raft (figure 23-24). There are three terms used to specify the severity or height of rollers; one being washboard. Washboard rollers are a series of swells which gently ripple and are safe and easy to ride. The next stage of rollers is called standing water (cresting rollers), where the speed of contours on the bottom are such that the tops of the swells fall back onto themselves. The most dangerous and insurmountable rollers are referred to as haystacks or roosters (figure 23-25). They resemble haystacks of water coming down from every direction—giant frothing bulges. They may be so high a raft cannot go over them. It would be easy to become trapped in a deep trough (depression) and be buried under tons of frothing water. These troughs also hide dangers such as sharp rocks which could tear a raft or break through the bottom of a boat.

i. Chutes. River chutes are good, logical travel routes, but they may harbor dangers. A chute (or tongue) is a

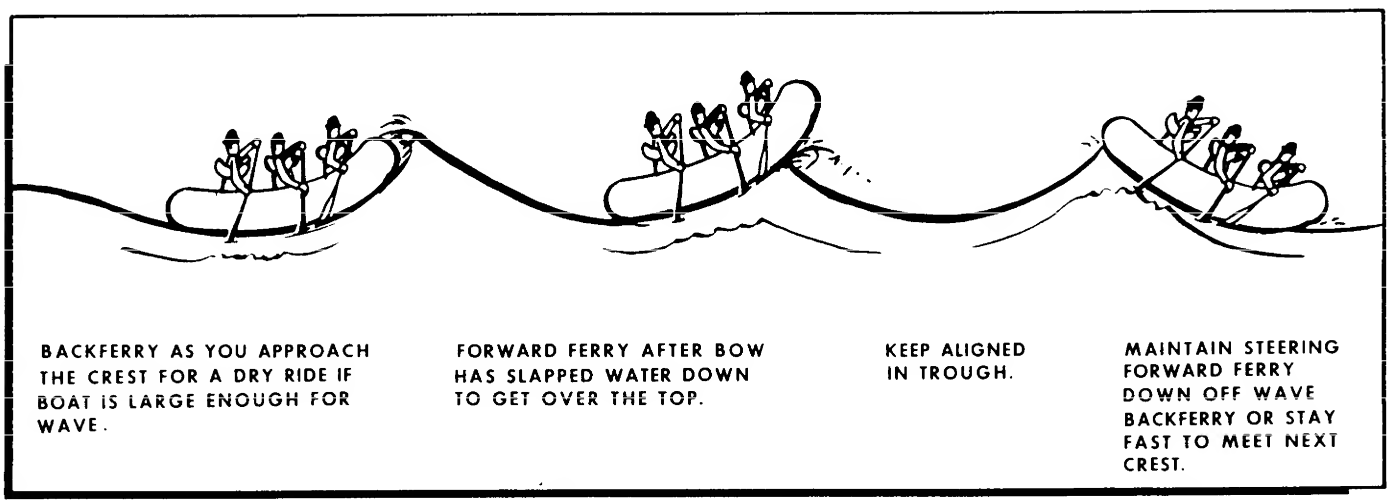


Figure 23-23. Tail Waves and Rollers.

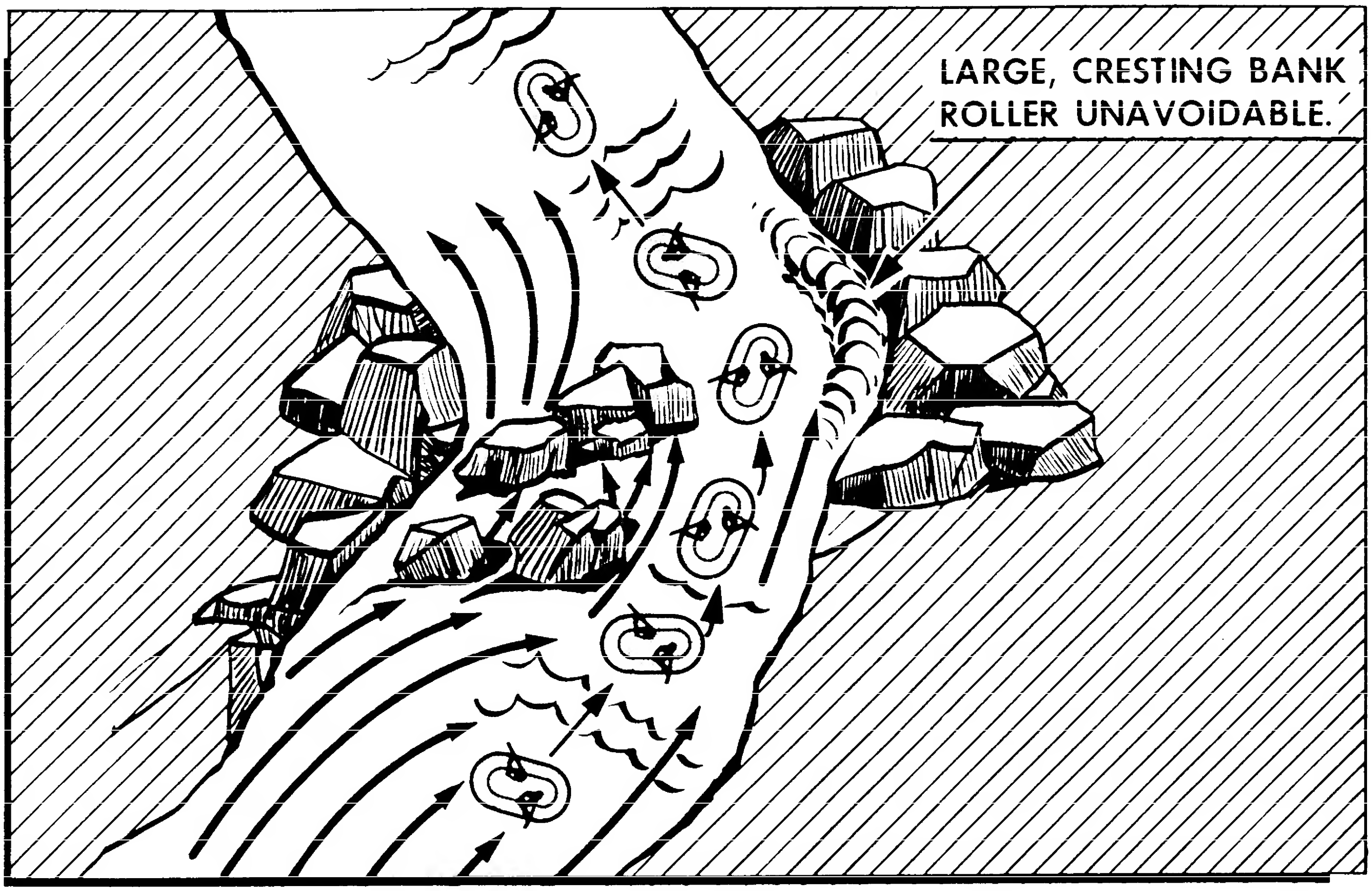


Figure 23-24. Bank Roller.

swift-running narrow passage between river obstructions caused by a damming effect. An example would be water forced between two large boulders. Because the waterflow is restricted, it accelerates and a powerful current rushes through. Because of the water velocity, there may be a suction hole on either side of the chute (figure 23-26).

j. Log Jams (Tongue of the Rapids). Log jams are extremely dangerous. They consist of logs, brush, and debris collected from high waters that become lodged across the current. They remain stationary while the river flows through them. If a craft should be swept up against the stationary logs, it will be pinned in place by the current. Should the craft be tipped and swamped, it could be swept under the log jam. If the current is strong

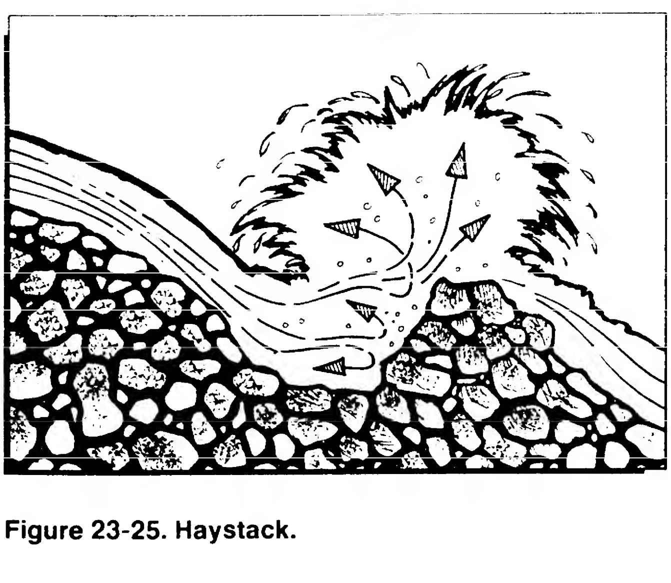


Figure 23-25. Haystack.

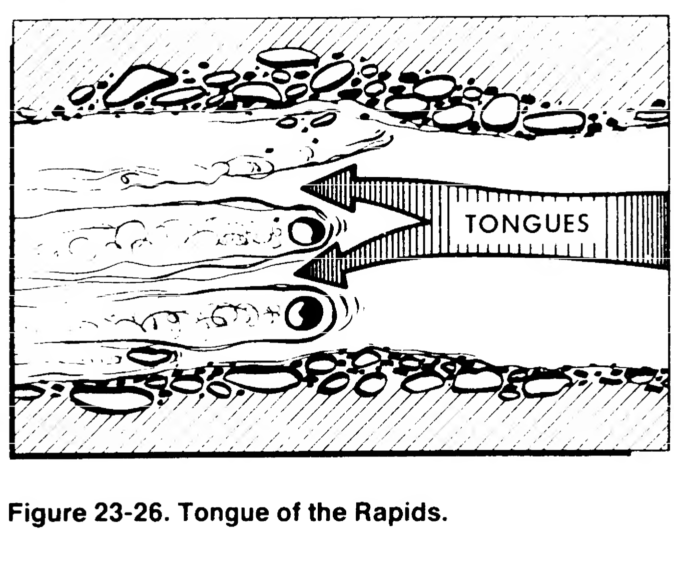


Figure 23-26. Tongue of the Rapids.

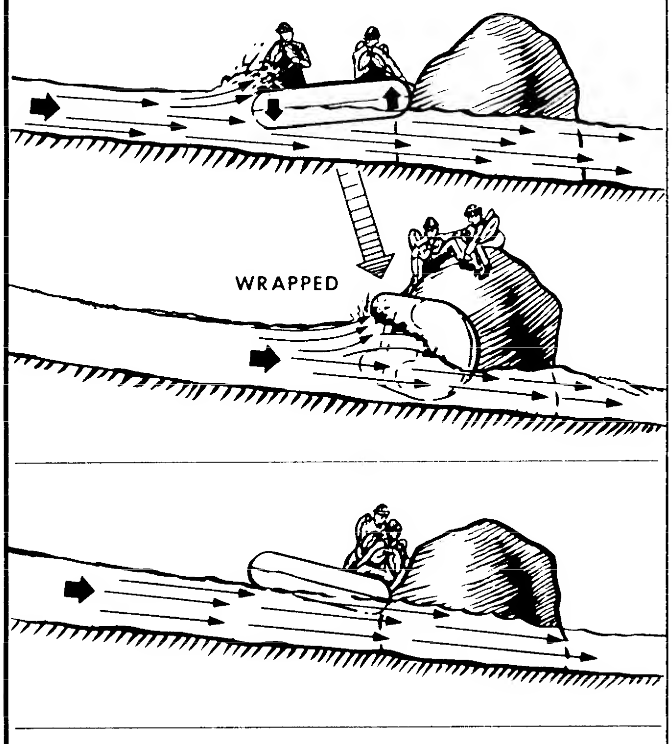
enough to do this, the occupants may also be pinned underneath the jam.

k. Sweepers. Sweepers can be the most dangerous obstructions in rivers. A sweeper is a large tree growing on a riverbank which has fallen over and is resting at or near the surface of the water. It may bounce up and down with the current. Survivors may be suddenly confronted with a sweeper which blocks the channel while rounding a bend in a river. The survivors are relatively helpless when it encounters sweepers in swift water. The only precautionary measure is to land above a bend in order to study the river ahead. (NOTE: Many people have met disaster by hitting sweepers.)

23-5. Emergency Situations:

a. Rock Collisions. Collisions with rocks above the surface of the water are common occurrences on a river. If the collision is unavoidable, survivors should spin the raft powerfully just before contact, or hit the rock bow-on. If the survivor is able to spin the raft, it will usually turn the raft off and around the rock. If they hit the rock bow-on, it will stop the raft momentarily, giving time to manipulate a spin-off with a few turn strokes. When the bow-on method is used, occupants in the stern (aft) should move to the center of the raft before impact. This allows the stern to raise and the rushing current to slide under the raft. If the stern is low, the water will pile against it causing the raft to be swamped. If survivors are colliding broadside with a rock, the entire crew must immediately jump to the side of the raft nearest the rock—always being the raft's downstream side (figure 23-27). This should be done before contact. If not, the river will flow over and suck down the raft's upstream tube. The raft will be flooded and the powerful force of the current will wrap it around the rock, possibly trapping some or all of the crew between the rock and the raft. Once it is unswamped, the broached (broadsided) raft on a rock is usually freed easily (figure 23-28). If two people push with both feet on the rock in the direction of the current, the raft will swing or slide into the pull of the current. The rest of the crew should shift to the end which is swinging into the current. These methods rarely fail; however, if the raft refuses to budge, it can be freed using the enormous power of the current. Large gear bags or sea anchors are securely tied to a long rope and secured to the end of the raft expected to swing downstream. The sea anchors (gear bags) are then tossed downstream into the current. (NOTE: A safety line should be used.)

b. Freeing a Wrapped Raft. Sometimes the powerful force of swift water may pin and wrap a raft around a rock. It is unusual for a raft to be equally balanced around the rock, so it will move more easily one way than it will the other. The part of the raft with more weight and bulk should be moved toward the flow of the current. Lines are attached to at least two points on the raft so, when pulled, the force is equally distributed. One of these points is on the far end of the raft, around the tube and is called the hauling line. (NOTE and CAUTION: A small hole may need to be cut in the floor of the raft to pass the line through and around the tube



HANDLING A BROADSIDE COLLISION WITH A ROCK

JUST BEFORE A RAFT BROADSIDES ON A ROCK, THE CREW SHOULD JUMP TO THE SIDE OF THE RAFT NEAREST THE ROCK. THIS LIFTS THE UPSTREAM TUBE AND ALLOWS THE CURRENT TO SLIDE EASILY UNDER THE RAFT. IF THE CREW IS NOT QUICK TO HOP TOWARD THE ROCK, SWIFT WATER WILL SPEEDILY SWAMP THE RAFT AND WRAP IT FLAT AROUND THE ROCK'S UPSTREAM FACE.

Figure 23-27. Handling Broadside Collision with Rock.

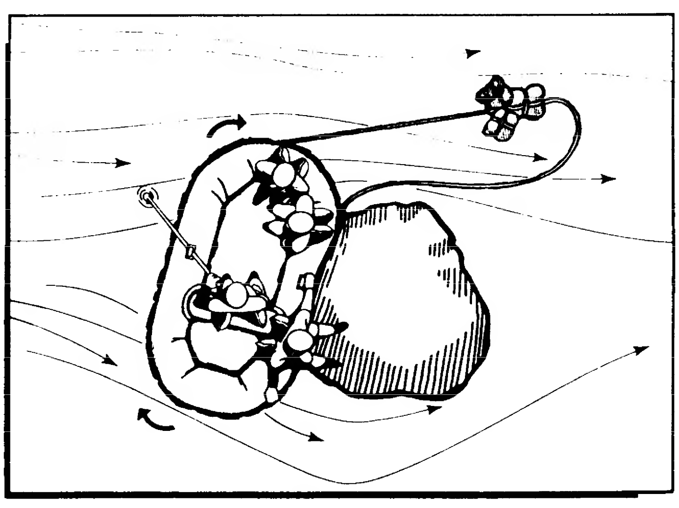


Figure 23-28. Freeing Unswamped Raft.

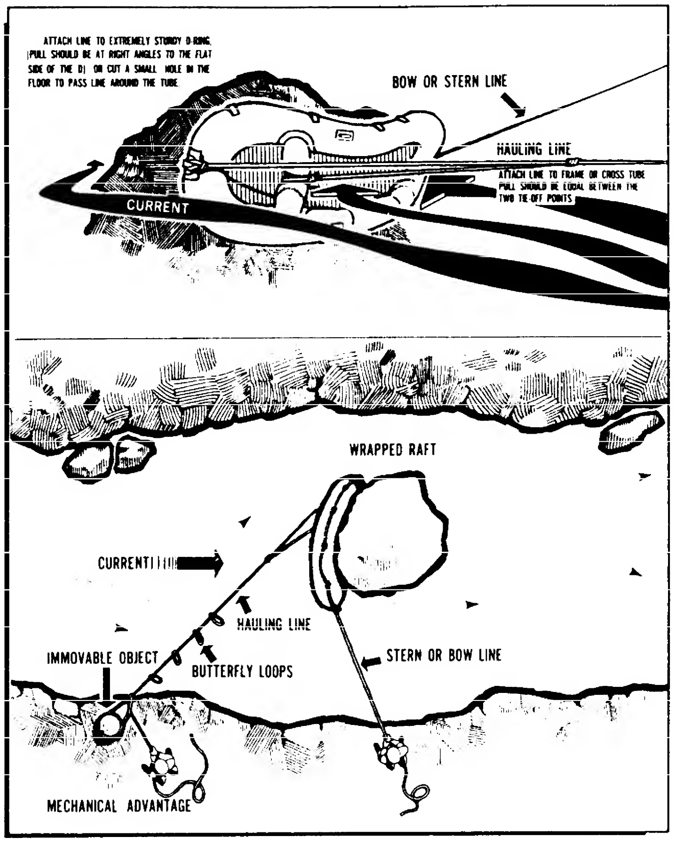


Figure 23-29. Freeing a Wrapped Raft.

if there is no ring to pass it through.) The second tie-off point can be a cross tube. One person should hold the line attached to the stern of the raft. The raft should be moved over the rock into the pull of the current. Once it is freed, the person holding the stern line can move the raft to a safe position.

c. Raft Flips. When a raft is about to flip, there is little time to react to the situation. If the raft is diving into a big hole, the primary danger is being violently thrown forward into a solid object in the raft. Survivors should protect themselves by dropping low and flattening themselves against the backside of the baggage or cross tube. If the raft is being upset by a rock, fallen tree, or other obstacles, members should jump clear of the raft to prevent being crushed against the obstruction or struck by the falling raft. If the raft is pinned flat against an obstruction, the members should stay with the raft and try to safely climb up the obstruction (figure 23-29).

d. Lining Unrunnable Rafts. Lining a raft through rapids is basically letting it run through rapids with a crew on shore controlling it by attached lines (figure 23-30). The raft should be moved slowly by maintaining tight control of the lines attached to the bow and stern. If no strong eddies or steep narrow chutes are present, one member should walk along the shore and control the raft with a strong, long line. The lines running to shore should be long enough to allow the raft full travel through the rapids.

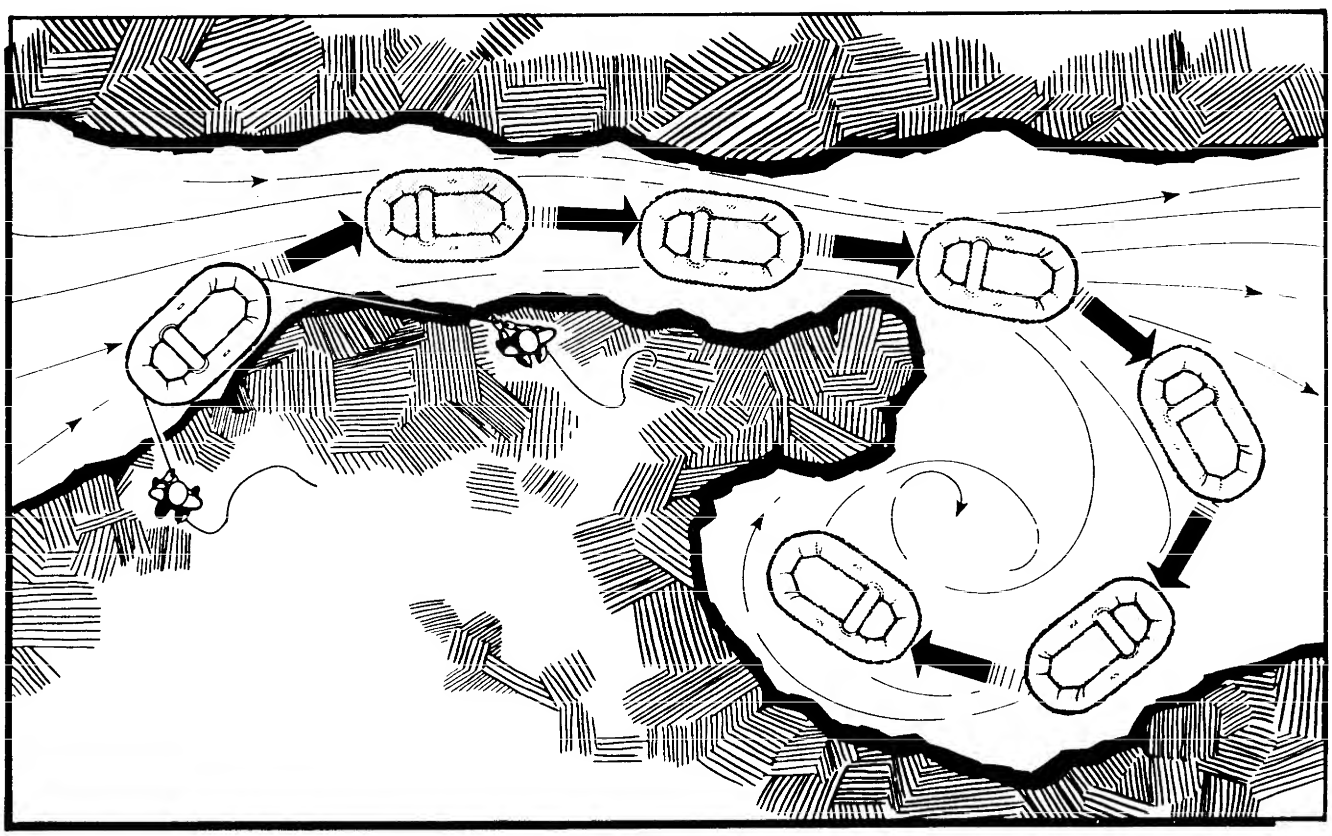


Figure 23-30. Lining a Chute.

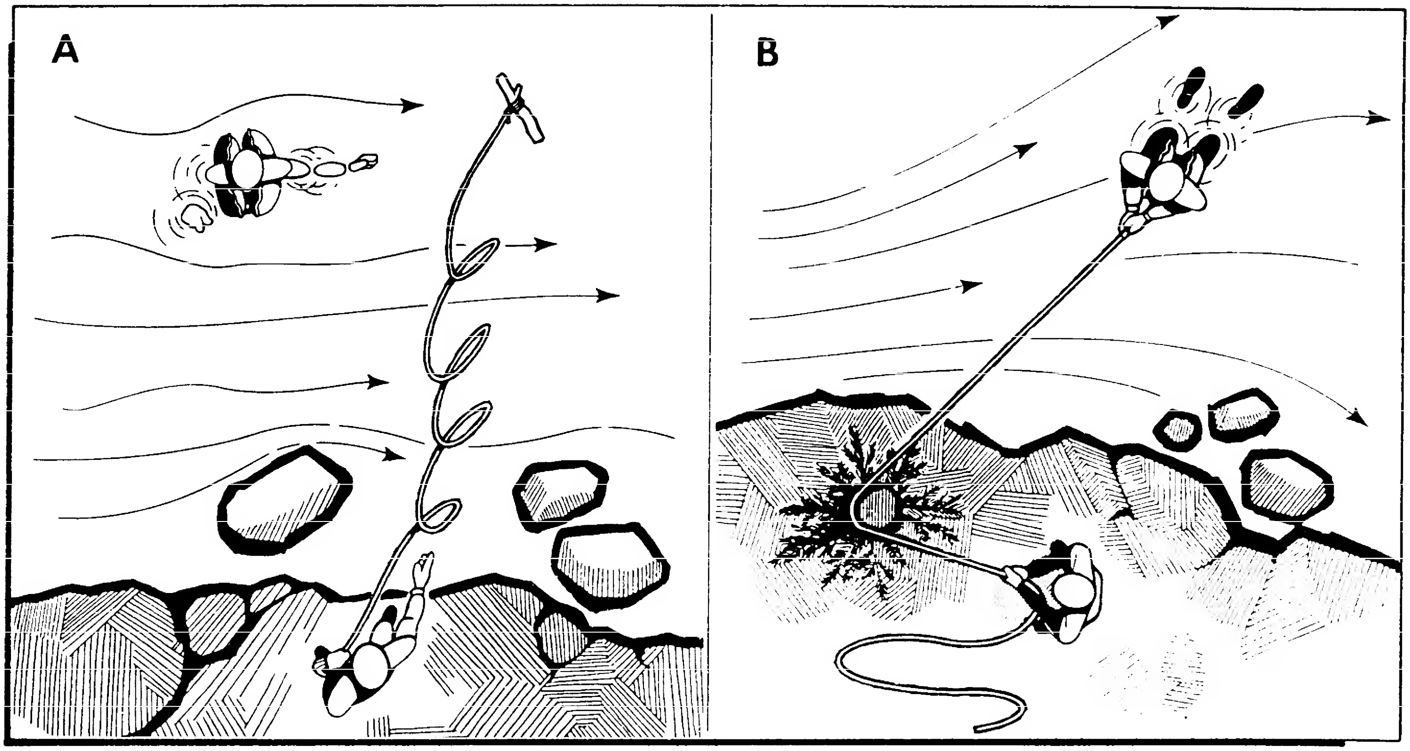


Figure 23-31. Making a Rescue.

e. Rescuing a Swimmer from Shore. The rescuer should carefully choose the right spot where the coil of rope thrown to the swimmer will not cross hazardous areas or obstacles, and yet be near a rock or tree which can be used for belaying (securing without being tied) the end of the line. The person throwing the line should make sure the line has a flotation device (life preserver) at the end before it is thrown to the swimmer. The rope should be coiled in a manner which will allow it to flow smoothly, without entanglement, to full extension. One hand holds one-half to one-third of the coil while the other throws the remainder of the coil out. The weighted coil should be thrown to a spot where the swimmer will drift, which is usually downstream, in front of the swimmer. As the rope travels out, all of the line except the last 10 or 12 feet should be uncoiled. The member

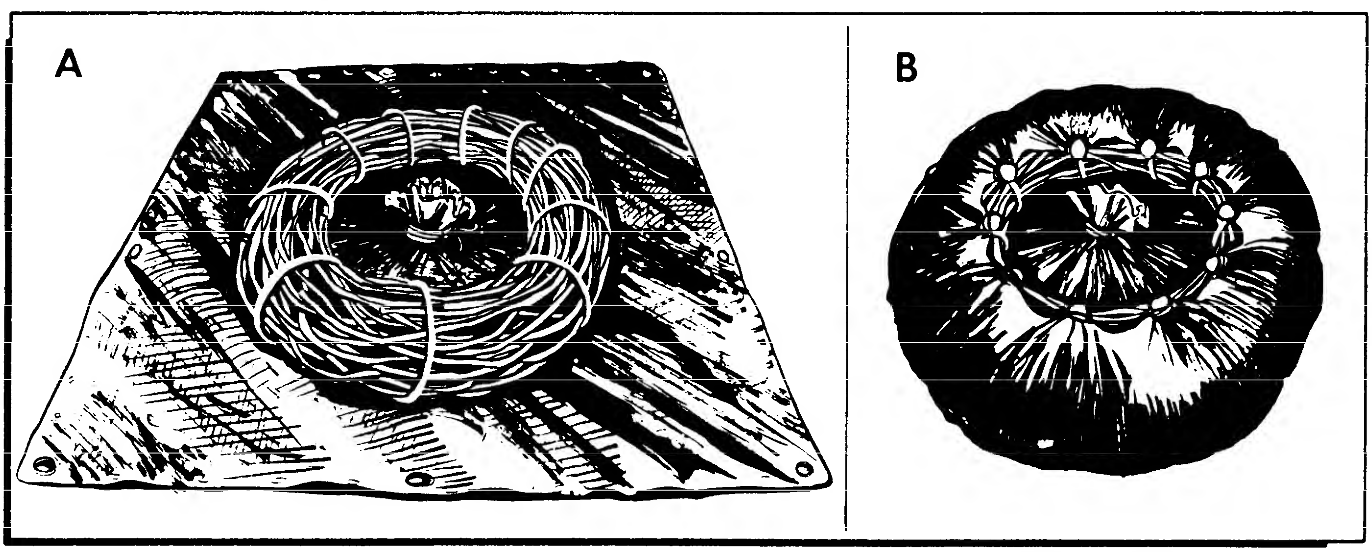


Figure 23-32. Poncho Ring Raft.

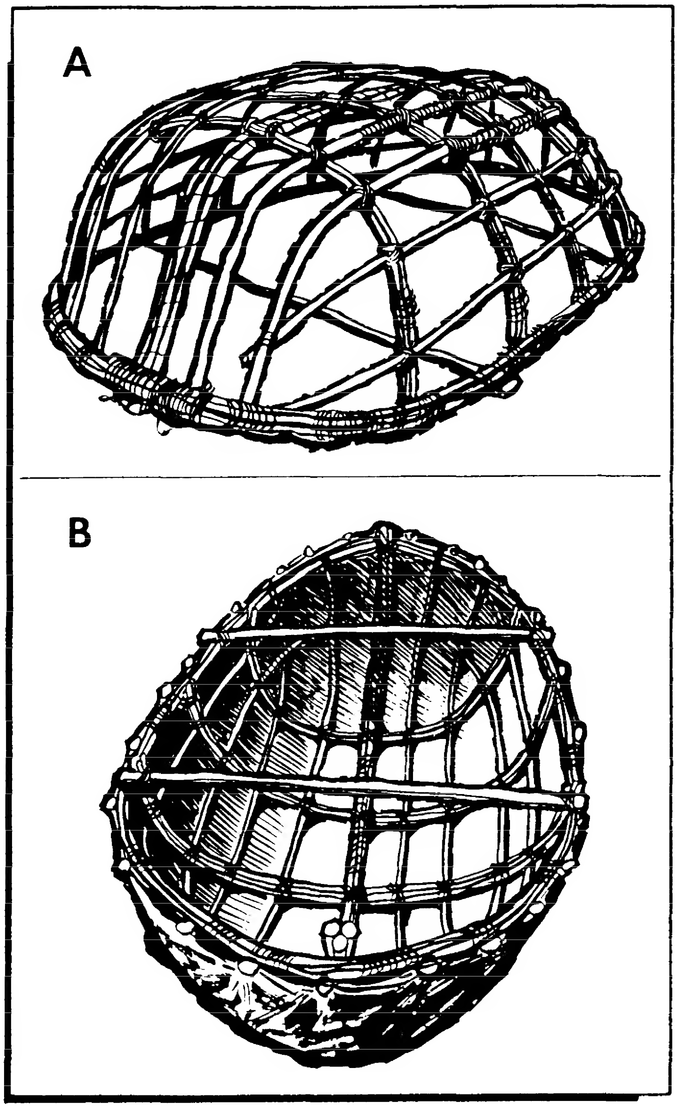


Figure 23-33. Bull Boat.

pulling the survivor should be braced or have the line around a rock or tree to hold the swimmer once the line has been reached by the survivor.

f. The Swimmer's Responsibility. The swimmer should be aware of the rescuer's location and face downstream when waiting for the hauling line. When the line is thrown, the swimmer will normally be required to swim to reach it. Once holding the line, the swimmer should be prepared for a very strong pull from the current and line. The line should be held tightly, but not wrapped around a wrist or hand! Entanglement must be avoided. The swimmer should pull, hand-over-hand, until reaching shallow water, and then use the rope for steadiness while walking to shore (figure 23-31).

23-6. Improvised Rafts:

a. Types of Flotation Devices. There are various types of flotation devices which may be improvised and used as rafts for equipment and personnel.

(1) The Poncho (donut) raft (figure 23-32) can be used for transporting equipment, but is not a good vehicle for people. The raft is constructed by using saplings or pliable willows and a waterproof cover. A hoop-shaped framework of saplings or pliable willow is constructed within a circle of stakes. The hoop is tied with cordage or suspension line and removed from the circle of stakes and placed on the waterproof cover to which it will be attached. Clothing and (or) equipment is then placed in the raft and the survivor swims, pushing the raft.

(2) The bull boat (figure 23-33) is a shallow-draft skin boat shaped like a tub and formerly used by Indians in the Great Plains area. The survivors should construct an oval frame, similar to a canoe, of willow or other pliable materials and cover the framework with waterproof material such as a signal paulin or skins. This makes a craft which is suitable for transporting equipment across a river with the survivor propelling it from behind.

(3) An emergency boat can be made by stretching a tarpaulin or light canvas cover over a skillfully shaped framework of willows and adding a well-framed keel of green wood, such as slender pieces of spruce. Gunwales (sides) of slender saplings are attached at both ends and the spreaders or thwarts are attached as in a canoe. Ribs of strong willows are tied to the keel. The ends of the ribs are bent upward and tied to the gunwales. The inside of the frame is closely covered with willows to form a deck upon which to stand. Such a boat is easy to handle and is buoyant, but lacks the strength necessary for long journeys. This boat is entirely satisfactory for ferrying a group across a broad, quiet stretch of river. When such a boat has served its purpose, the cover should be removed for later use.

(4) The vegetation raft is built of small vegetation which will float and is placed within clothing or parachute to form a raft for a survivor and (or) equipment. Plants such as water hyacinth or cattail may be used (figure 23-34).

(5) A good floating device for the single survivor can be fabricated by using two balsa logs or other lightweight wood. The logs should be placed about 2 feet apart and tied together. The survivor sits on the lines and travels with the current (figure 23-35).

(6) A dugout canoe is good transportation, but difficult to construct. One method is to build a long fire on the side to be dug out and chop away the burned material when the fire is out. Repeat this procedure as often as necessary.

b. Building a Raft. The greatest problem in raft construction (figure 23-36) is being able to construct a craft strong enough to withstand the buffeting it may have to take from rocks and swift water. Even if 6- to 8-inch

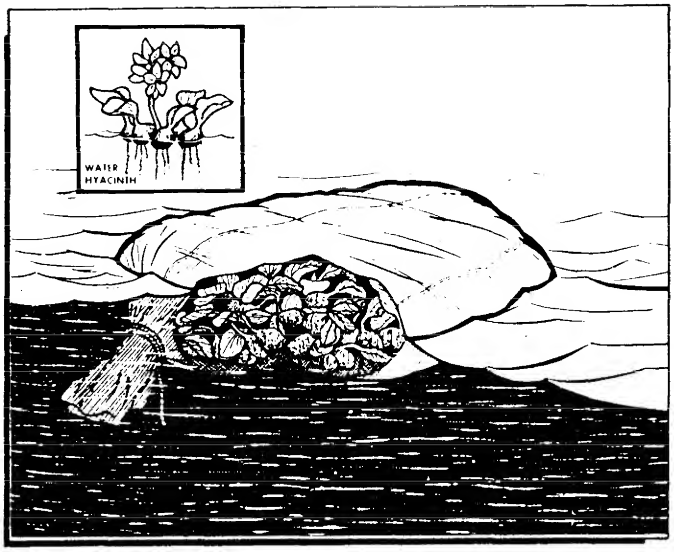


Figure 23-34. Vegetation Bag.

spikes are available, they are not satisfactory since they pull or twist out easily. Rope quickly wears out from frequent, rough contact with rocks and gravel. Northern woodsmen have evolved a construction method (figure 23-37) which requires neither spikes nor rope, yet produces a raft superior in strength. The only material required are logs, although rope is sometimes useful; the only tools needed are an axe and a sheath knife.

23-7. Fording Streams:

a. Survivors traveling on foot through wilderness areas may have to ford some streams. These can range from small, ankle-deep brooks to large rivers. Rivers are often so swift a survivor can hear boulders on the bottom being crashed together by the current. If these streams are of glacial origin, the survivor should wait for them to decrease in strength during the night hours before attempting to ford.

b. Careful study is required to find a place to safely ford a stream. If there is a high vantage point beside the river, the survivor should climb the rise and look over the river. Finding a safe crossing area may be easy if the river breaks into a number of small channels. The area on the opposite bank should be surveyed to make sure travel will be easier after crossing. When selecting a fording site, the survivor should:

(1) When possible, select a travel course which leads across the current at about a 45-degree angle downstream.

(2) Never attempt to ford a stream directly above, or close to, a deep or rapid waterfall or a deep channel. The stream should be crossed where the opposite side is comprised of shallow banks or sandbars.

(3) Avoid rocky places, since a fall may cause serious injury. However, an occasional rock which breaks the current may be of some assistance. The depth of the water is not necessarily a deterrent. Deep water may run more slowly and be safer than shallow water.

(4) Before entering the water, the survivors should have a plan of action for making the crossing. Use all possible precautions, and if the stream appears treacherous, take the steps shown in figure 23-38.

23-8. Traveling on Open Seas. Four-fifths of the Earth's surface is covered by open water. Although accounts of sea survival incidents are often gloomy, successful survival is possible; however, the raft is at the mercy of the currents and winds. There are many currents, both warm and cold, throughout the seas.

a. Currents. Sea currents flow in a clockwise direction in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. This is caused by three factors: the Sun's heat, the winds, and the Earth's rotation (Coriolis Effect). Most sea currents travel at speeds of less than 5 miles per hour. Using currents as a mode of travel can be done by putting out the sea anchor and letting the current pull the raft along. Survivors should

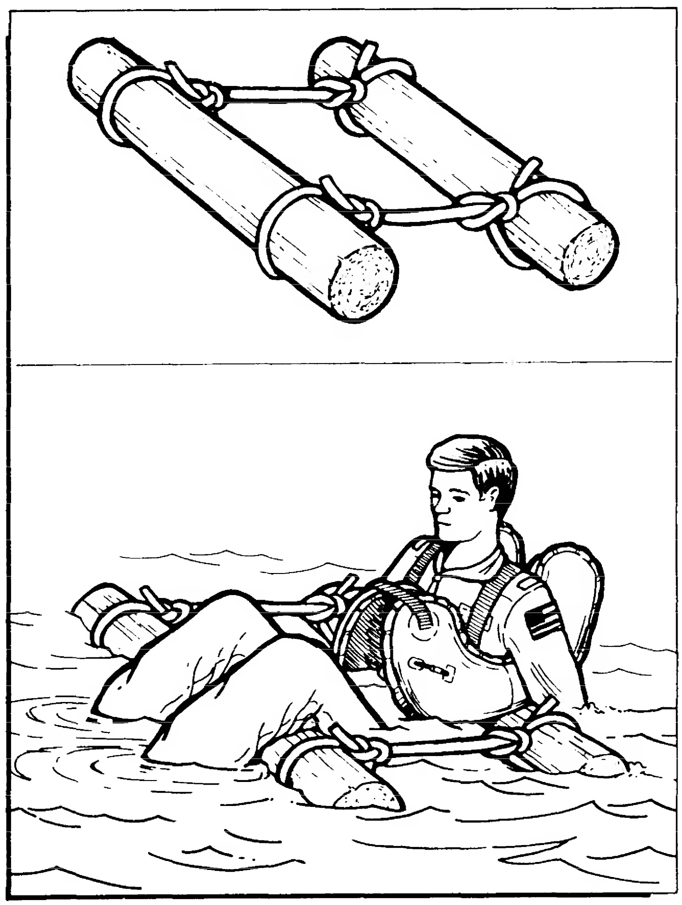
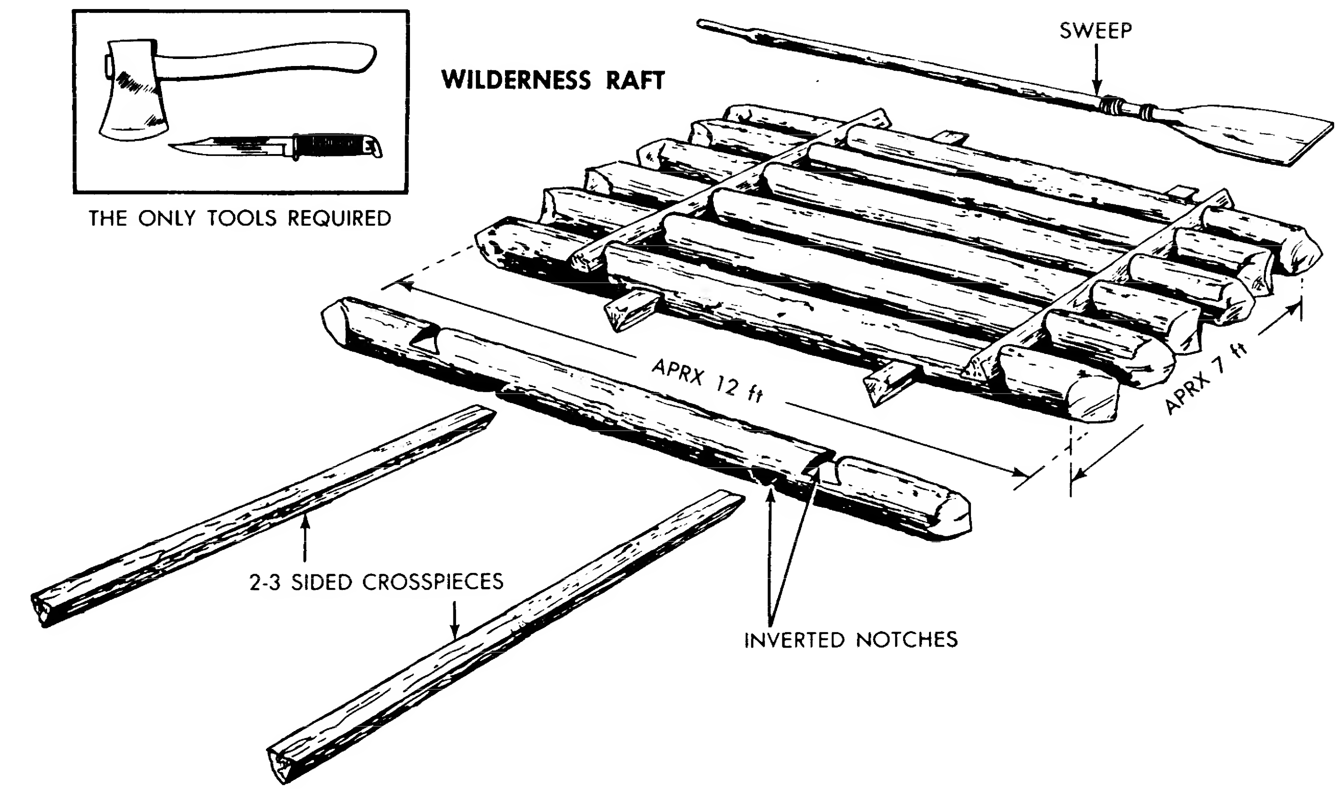


Figure 23-35. Log Flotation.



RAFT CONSTRUCTION

A raft for three persons should be about 12 feet long and 6 feet wide, depending on the size of the logs used. The logs should be 12 to 14 inches in diameter and so well matched in size that notches you make in them are level when crosspieces are driven into place.

Build the raft on two skid logs placed so that they slope downward to the bank. Smooth the logs with an ax so that the raft logs lie evenly on them. Cut two sets of slightly offset inverted notches, one in the top and bottom of both ends of each log. Make the notches broader at the base than at the outer edge of the log, as shown in the illustration. Use small poles with straight edges or a string pulled taut to make the notches. A three-sided wooden crosspiece about a foot longer than the total width of the raft is to be driven through each end of the four sets of notches.

Complete the notches on all logs at the top of the logs. Turn the logs over and drive a 3-sided crosspiece through both sets of notches on the underside of the raft. Then complete the top set of notches and drive through the two additional sets of crosspieces.

You can lash together the overhanging ends of the two crosspieces at each end of the raft to give it added strength; however, when the crosspieces are immersed in water they swell and tightly bind the raft logs together.

If the crosspieces fit too loosely, wedge them with thin, boardlike pieces of wood split from a dead log. When the raft is in water, the wood swells, and the crosspieces become very tight and strong.

Make a deck of light poles on top of the raft to keep packs and other gear dry.

Figure 23-36. Raft Construction.

use caution when traveling through areas where warm and cold currents meet. It can be a storm forming area with dense fog and high winds and waves.

b. Winds. Winds also aid raft travel. In tropical areas, the winds are easterly blowing (trade winds). In higher latitudes, they blow from the west (westerlies). To use the winds as a mode of travel, the sea anchor should be pulled into the raft and, if available, a sail should be erected.

c. Waves. Waves can be both an asset and a hazard to raft travel. Waves are normally formed by the wind. The severity of the wind determines the size of the waves. On open seas, waves range from a few inches to over 100 feet in height. Under normal conditions, waves alone will move a liferaft only a few inches at a time; therefore, using waves as a mode of propulsion is not practical. Waves are a great help in finding land or shallow areas in the sea. Ocean waves always break when they enter shallow water or when they encounter an obstruction. The force of energy of the wave depends on how abruptly the water depth decreases and the size of the waves. Breaking waves can be used as an aid to

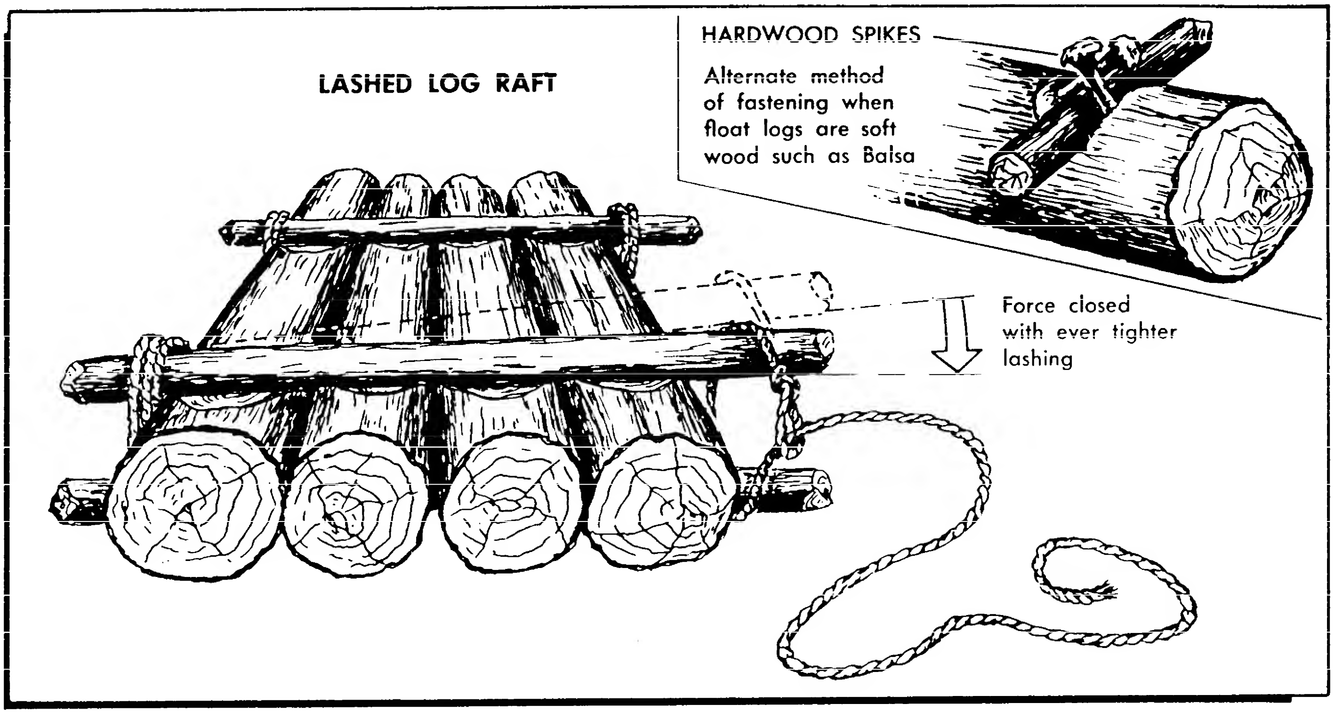


Figure 23-37. Lashed Log Raft.

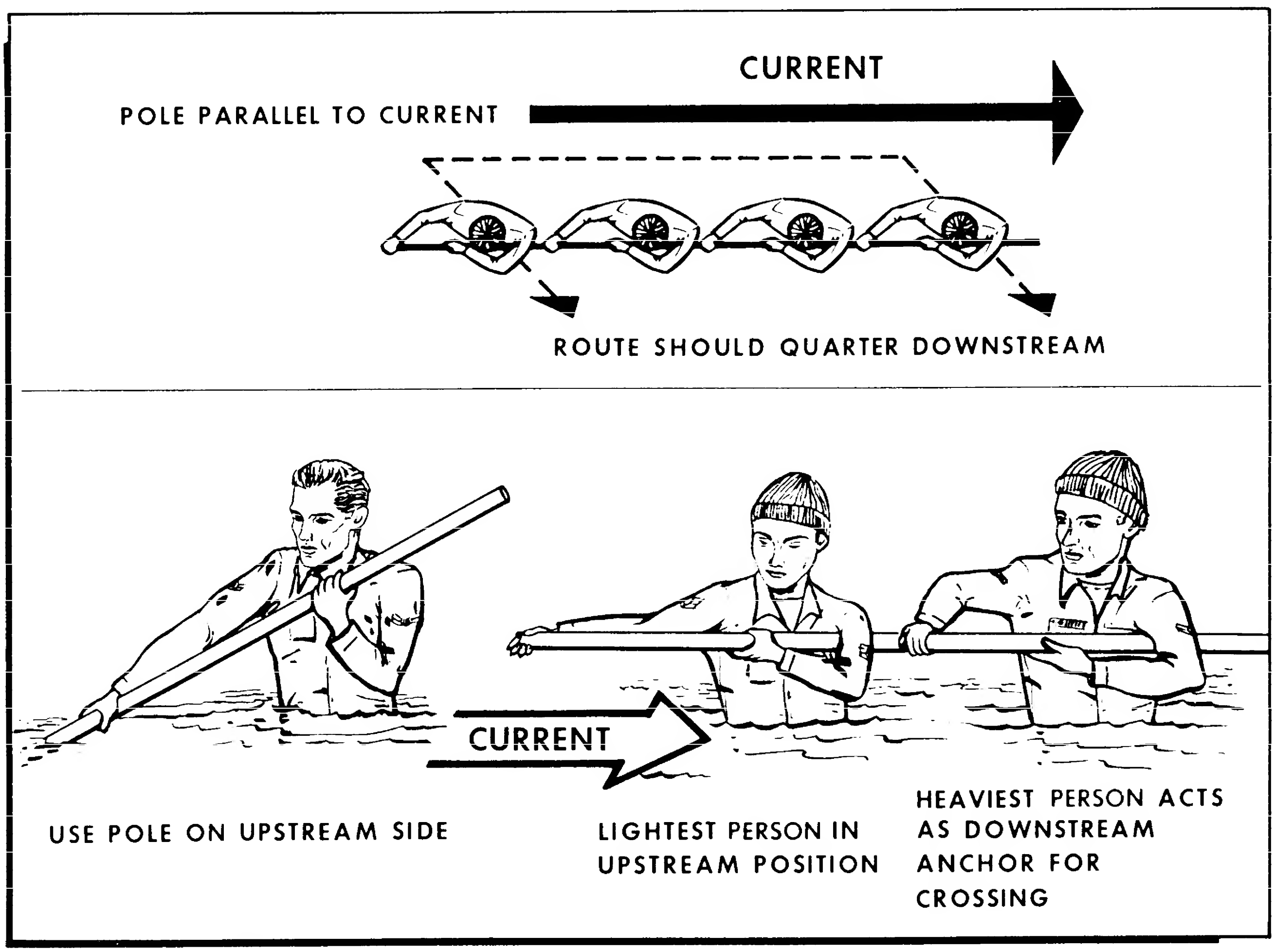


Figure 23-38. Fording a Treacherous Stream.

make a landfall. Storms at sea are probably the greatest hazard to survivors in rafts. Aside from the waves created by a storm, the wind and rain can make life in a raft very difficult. The waves and wind can capsize a raft, or throw a person out of the raft, and then will constantly fill the raft with water. Seasickness can result from gentle to severe wave action. Additionally, rescue efforts may be severely hampered by large waves.

d. Tides. Tides are another form of wave but they are very predictable. They occur twice daily and usually cause no problems for anyone in a raft. Tides may range from one to 40 feet in height depending on the area of the world. They should be considered when planning a landing. When the tide is going in, it will help propel the raft to shore. The action of the water going away from shore when the tide is going out makes landing difficult.

e. Hazards. Certain marine life must be considered a hazard to survival. Sharks, jellyfish, eels, and most reef fishes can cause serious injuries if encountered. Waste materials should be disposed of when these creatures are not present.

(1) The survivor should be aware of the saltwater (estuarine) crocodile. It is found throughout the Southeast Asian shoreline. It is a well known maneater, and is almost always found in salt or brackish water. It is more commonly found near river mouths and along the coasts; however, it has been known to swim as much as 40 miles out into the sea. Females with nests are likely to be vicious and aggressive. They will grow to a length of 30 feet but most specimens are less than 15 feet in length. Survivors should watch for this reptile while landing their raft or fishing.

(2) The survivor will normally encounter reef fishes during the landing process by stepping on them. They may also be caught while fishing. Clothing and footgear must be worn at all times whether landing raft or fishing.

(3) Coral is normally found in warm waters, along the shores of islands and mainlands. There are many different types of coral. They should be avoided since all can destroy a raft or severely injure a survivor. It is best to stay in the raft when coral is encountered. If the survivor must wade to shore, footgear and pants should be worn for protection. Moving slowly and watching every step may prevent serious injuries. Coral does not exist where freshwater enters the sea.

(4) Ships can be a welcome sight to the survivor, but they can also be a hazard. Since the raft is a small object in a very large sea, the survivor must constantly be aware that at night or during inclement weather, the raft will be difficult to see and could be struck by a large ship.

f. Early Considerations. Survivors should stay upwind and clear of the aircraft (out of fuel covered waters) but in the vicinity of the crash until the aircraft sinks. A search for survivors is usually activated around the entire area of and near the crash site. Missing personnel may be unconscious and floating low in the water. Rescue procedures are illustrated in figure 23-39.

(1) The best technique for rescuing aircrew members from the water is to throw them a line with a life preserver attached. The second is to send a swimmer (rescuer) from the raft with a line using a flotation device which will support the weight of a rescuer. This will help to conserve energy while recovering the survivor. The least acceptable technique is to send an attached swimmer without floatable devices to retreive a survivor. In all cases, the rescuer should wear a life preserver. The strength of a person in a state of panic in the water should not be underestimated. A careful approach can prevent injury to the rescuer.

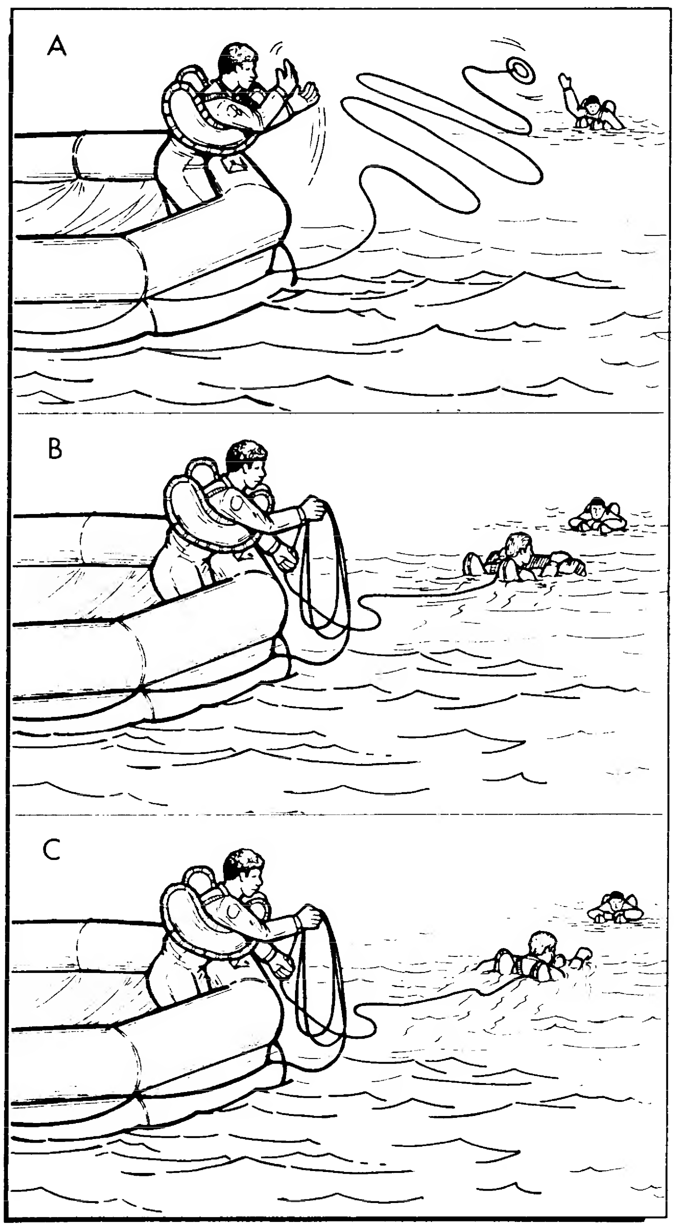


Figure 23-39. Rescue from Water.

(2) When the rescuer is approaching a survivor in trouble from behind, there is little danger of being kicked, scratched, or grabbed. The rescuer should swim to a point directly behind the survivor and grasp the backstrap of the life preserver. A sidestroke may then be used to drag the survivor to the raft.

(3) All debris from the aircraft should be inspected and salvaged (rations, canteens, thermos and other containers, parachutes, seat cushions, extra clothing, maps, etc). Secure equipment to the raft to prevent loss. Special precaution should be taken with flashlights and signaling equipment to keep them dry so they will function when needed.

(4) Rafts should be checked for inflation. Leaks, and points of possible chafing should be repaired, as required. All water should be removed from inside the raft. Care should be taken to avoid snagging the raft with shoes or sharp objects. Placing the sea anchor out will slow the rate of drift. If there is more than one raft, they should be connected with at least 25 feet of line. The lifeline attached to the outer periphery of the raft is to be used for the connection. Donning the antiexposure suit is essential in cold climates. Erecting wind breaks, spray shields, and canopies will protect survivors from the elements. Survivors should huddle together and exercise regularly to maintain body heat.

(5) Monitoring the physical condition of survivors and administering first aid to survivors is essential. If available, seasickness pills will help prevent vomiting and resulting dehydration.

(6) Survivors should prepare all available signaling equipment for immediate use.

(7) Compasses, watches, matches, and lighters will become worthless unless they are kept dry.

(8) The raft repair plugs should be attached to the raft for easy access as soon as possible.

(9) All areas of the body should be protected from the Sun. Precautions should be taken to prevent sunburn on the eyelids, under the chin, and on the backs of the ears. Sunburn cream and Chapstick will protect these areas.

(10) The leader should calmly analyze the situation and plan a course of action to include duty assignments (watch duty, procuring and rationing food and water, etc.). All survivors, except those who are badly injured or completely exhausted, are expected to perform watch duty, which should not exceed 2 hours. The survivor on watch should be looking for signs of land, passing vessels or aircraft, wreckage, seaweed, schools of fish, birds, and signs of chafing or leaking of the raft.

(11) Food and water can be conserved by saving energy. Survivors should remain calm.

(12) Maintaining a sense of humor will help keep morale high.

(13) The survivor(s) should remember that rescue at sea is a cooperative effort. Search aircraft contacts are limited by the visibility of survivors based on the availability of visual or electronic signaling devices. Visual and electronic communications can be increased by using all available signaling devices (signal mirrors, radios, signal panels, dye marker, and other available devices) when an aircraft is in the area.

(14) A log should be maintained with a record of the navigator's last fix, time of ditching, names and physical condition of survivors, ration schedule, winds, weather, direction of swells, times of sunrise and sunset, and other navigation data.

23-9. Physical Considerations:

a. The greatest problem a survivor is faced with when submerged in cold water is death due to hypothermia. When a survivor is immersed in cold water, hypothermia occurs rapidly due to the decreased insulating quality of wet clothing and the fact that water displaces the layer of still air which normally surrounds the body. Water causes a rate of heat exchange approximately 25 times greater than air at the same temperature. The following lists life expectancy times:

Temperature of Water	*Time*
70° - 60°	12 hours
60° - 50°	6 hours
50° - 40°	1 hour
40° - below	-1 hour

NOTE: These times may be increased with the wearing of an antiexposure suit.

b. The best protection for a survivor against the effects of cold water is to get into the liferaft, stay dry, and insulate the body from the cold surface of the bottom of the liferaft. If this is not possible, wear of the antiexposure suits will extend a survivor's life expectancy considerably. It's important to keep the head and neck out of the water and well insulated from the cold water effects when the temperature is below 66°F. The wearing of life preservers increases the predicted survival time just as the body position in the water increases the probability of survival. The following table shows predicted survival times for an average person in 50°F water:

Situation	*Predicted Survival Time (Hours)*
No Flotation	
Drownproofing	1.5
Treading Water	2.0
With Flotation	
Swimming	2.0
Holding Still	2.7
Help	4.0
Huddle	4.0

Figure 23-40. HELP Position.

(1) Help Body Position. Remaining still and assuming the fetal position, or heat escape lessening posture (HELP) (figure 23-40), will increase the downed crewmember's survival time. About 50 percent of the heat is lost from the head. It is therefore important to keep the head out of the water. Other areas of high heat loss are the neck, the sides, and the groin.

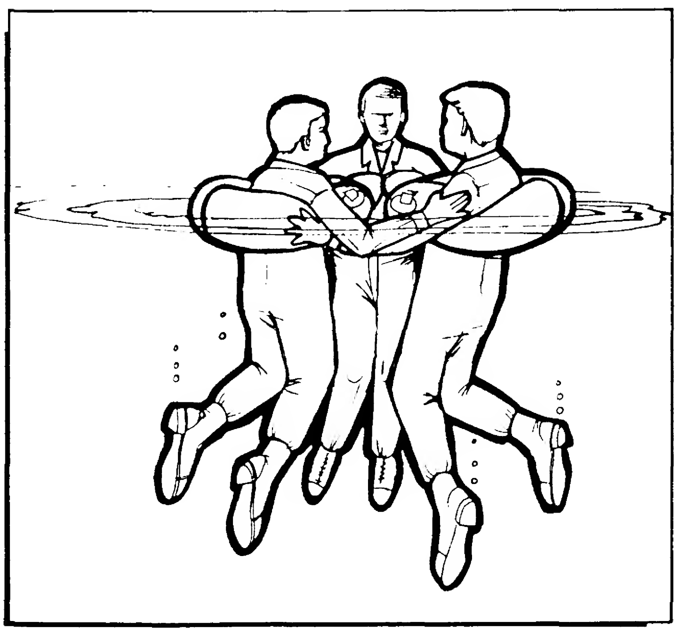


Figure 23-41. Huddling for Temperature Conservation.

(2) Huddling. If there are several survivors in the water, huddling close, side to side in a circle, body heat will be preserved (figure 23-41).

23-10. Life Preserver Use:

a. Survival Swimming Without a Life Preserver. A survivor who knows how to relax in the water is in little danger of drowning, especially in saltwater where the body is of lower density than the water. Trapped air in clothing will help buoy the survivor in the water. If in the water for long periods, the survivor will have to rest from treading water. The survivor may best do this by floating on the back. If this is not possible, the following technique should be used: Rest erect in the water and inhale; put the head face-down in the water and stroke with the arms; rest in this facedown position until there is a need to breathe again; raise the head and exhale; support the body by kicking arms and legs and inhaling; then repeat the cycle.

b. Swimming With a Life Preserver. The bulkiness of clothing, equipment, and (or) any personal injuries will necessitate the immediate need for flotation. Normally, a life preserver will be available for donning before entering the water.

(1) Proper inflation of the life preserver must be done after clearing the aircraft but, preferably, before entering the water. Upon entering the water, the two cells of the life preserver should be fastened together. Limited swimming may be done with the life preserver inflated by cupping the hands and taking strong strokes deep into the water. The life preserver may be slightly deflated to permit better arm movement.

(2) The backstroke should be used to conserve energy when traveling long distances. If aiding an injured or unconscious person, the sidestroke may have to be used. When approaching an object, it is best to use the breaststroke. If a group must swim, they should try to have the strongest swimmer in the lead with any injured persons intermingled within the group. It is best to swim in a single file.

23-11. Raft Procedures. There are three needs which can be satisfied by most of the rafts; they are personal protection, mode of travel, and evasion and camouflage.

a. One-Man Raft:

(1) The one-man raft has a main cell inflation. If the CO_2 bottle should malfunction and not inflate the raft or if the raft develops a leak, it can be inflated orally. The spray shield acts as a shelter from the cold, wind, and water. In some cases, this shield serves as insulation. The insulated bottom plays a significant role in the survivor's protection from hypothermia by limiting the conduction of the cold through the bottom of the raft (figure 23-42).

(2) Travel is more effectively made by inflating or deflating the raft to take advantage of the wind or cur-

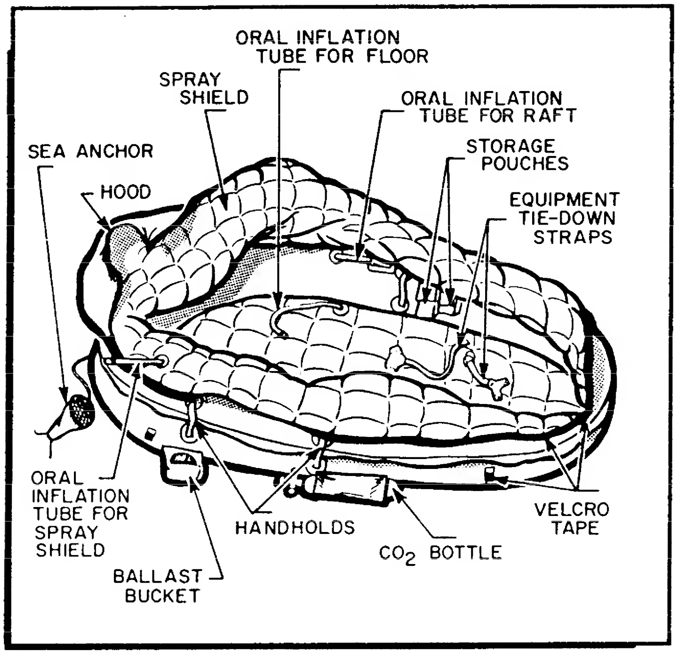


Figure 23-42. One-Man Raft with Spray Shield.

rent. The spray shield can be used as a sail while the ballast buckets serve to increase raft drag in the water. The last device which may be used to control the speed and direction of the raft is the sea anchor. (NOTE: The primary purpose of the sea anchor is to stabilize the raft.)

(3) Black rafts have been developed for use in tactical areas. These rafts blend with the background of the sea. The raft can be further modified for evasion by partially deflating which provides a low profile.

(4) The one-man raft is connected to the aircrew member by a lanyard parachuting to the water. Survivors should not swim to the raft, but pull it to their position via the lanyard. The parachute J-1 releases should be closed and the life preserver separated before boarding the raft (figure 23-43). The raft may hit the water upside down, but may be righted by approaching the bottle side and flipping it over. The spray shield must be in the raft to expose the boarding handles.

(5) If the survivor has an arm injury, boarding is best done by turning the back to the small end of the raft, pushing the raft under the buttocks and lying back (figure 23-44). Another method of boarding is to push down on the small end until one knee is inside and lie forward (figure 23-44).

(6) In rough seas, it may be easier for the survivor to grasp the small end of the raft, and, in a prone position, kick and pull into the raft. Once in the raft, lying face down, the sea anchor should be deployed and adjusted. To sit upright in the raft, one side of the seat kit might have to be disconnected and the survivor should roll to that side. The spray shield is then adjusted. There are two variations of the one-man raft, with the improved model incorporating an inflatable spray shield and floor for additional insulation. The spray shield is designed to help keep the survivor dry and warm in cold oceans, and protect them from the Sun in the hot climates (figure 23-45).

(7) The sea anchor can be adjusted to either act as a drag by slowing down the rate of travel with the current or as a means of traveling with the current. This is done by opening or closing the apex of the sea anchor. When opened, the sea anchor (figure 23-46) will act as a drag and the survivor will stay in the general area. When the sea anchor is closed (figure 23-46), it will form a pocket for the current to strike and propel the raft in the direction of the current. Additionally, the sea anchor should be adjusted so that when the raft is on the crest of a wave, the sea anchor is in the trough of the wave (figure 23-47).

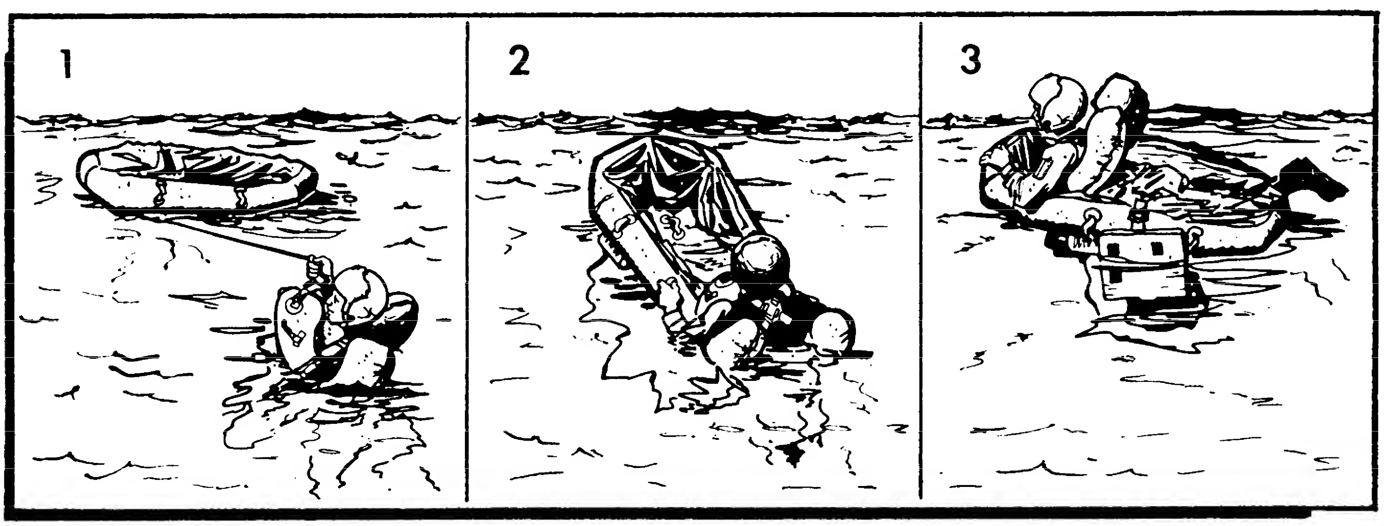


Figure 23-43. Boarding One-Man Raft.

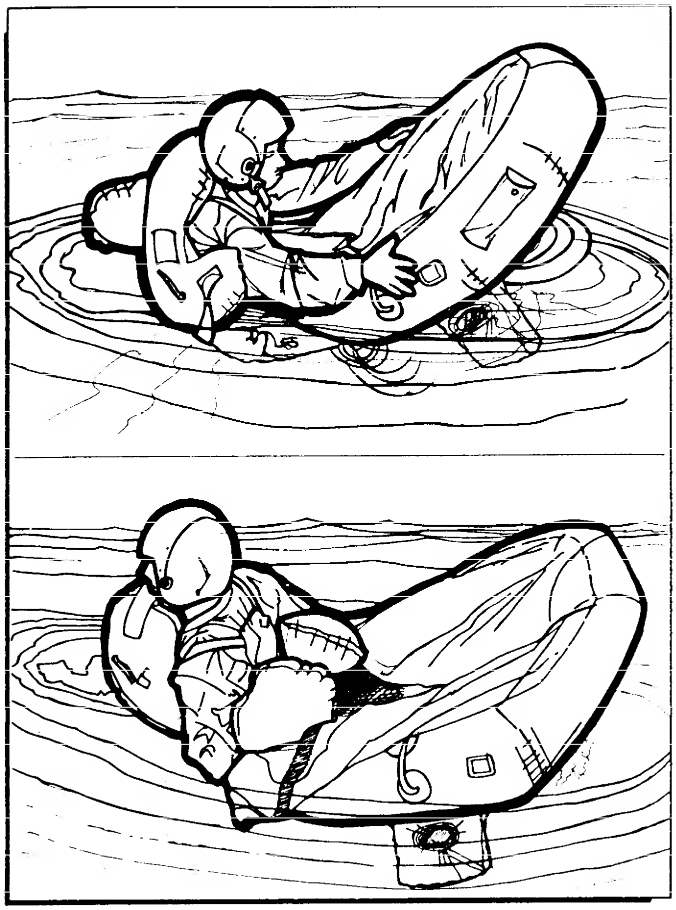


Figure 23-44. Boarding One-Man Raft (Other Methods).

Figure 23-45. One-Man Raft with Spray Shield Inflated.

b. Seven-Man Raft:

(1) The seven-man raft is found on some multiplace aircraft. It can also be found in the survival drop kit (MA-1 Kit, figure 23-48). This type of raft may inflate upside down and may, therefore, require the survivor to right the raft before boarding. The J-1 releases should be closed before boarding. The survivor should always work from the bottle side to prevent injury if the raft turns over. Facing into the wind provides additional assistance in righting the raft. The handles on the inside bottom of the raft are used for boarding (figure 23-49).

(2) The boarding ladder is used to board if someone assists in holding down the opposite side. If no assistance is available, the survivor should again work from the bottle side with the wind at the back to help hold down the raft. The survivor should separate the life preserver, grasp an oarlock and boarding handle, kick the legs to get the body prone on the water, and then kick and pull into the raft. If the survivor is weak or injured, the raft may be partially deflated to make boarding easier (figure 23-50).

(3) Manual inflation can be done by using the pump to keep buoyancy chambers and cross-seat firm, but the raft should not be over inflated. The buoyancy chambers and cross-seat should be rounded but not drum tight. Hot air expands, so on hot days, some air may be released while air may be added on cold days (figure 23-51).

c. Sailing a Raft into the Wind. Rafts are not equipped with keels, so they cannot be sailed into the wind. However, anyone can sail a raft downwind, and multiplace (except 20/25-man) rafts can be successfully sailed 10 degrees off from the direction of the wind. An attempt to sail the raft should not be made unless land is near. If the decision to sail is made and the wind is blowing toward a desired destination, survivors should fully inflate the raft, sit high, take in the sea anchor, rig a sail, and use an oar as a rudder as shown in figure 23-52.

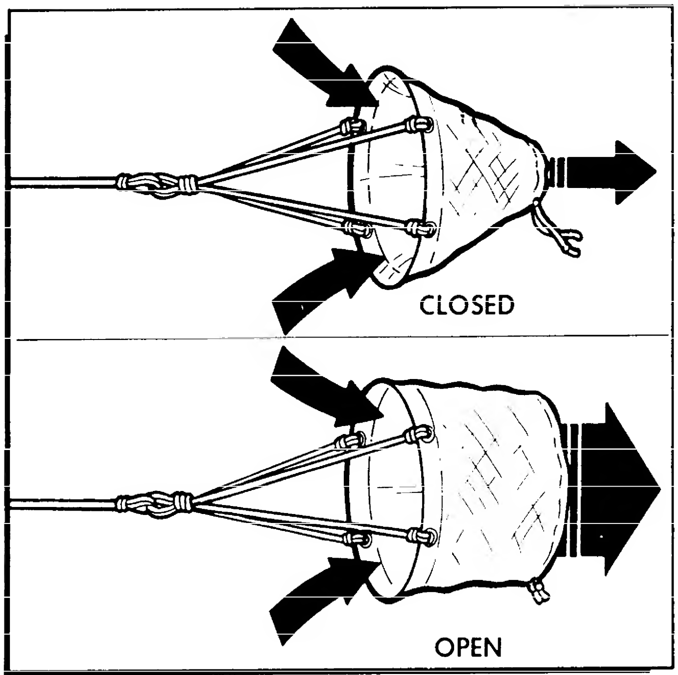


Figure 23-46. Sea Anchor.

d. Multiplace Raft. In a multiplace (except 20/25-man) raft, a square sail should be erected in the bow using oars with their extensions as the mast and crossbar (figure 23-52). A waterproof tarpaulin or parachute material may be used for the sail. If the raft has no regular mast socket and step, the mast may be erected by tying it securely to the front cross-seat using braces. The bottom of the mast must be padded to prevent it from chafing or punching a hole through the floor whether or not a socket is provided. The heel of a shoe, with the toe wedged under the seat, makes a good improvised mast step. The corners of the lower edge of the sail should not be secured. The lines attached to the corners are held with the hands so that a gust of wind will not rip the sail, break the mast, or capsize the raft. Every precaution must be taken to prevent the raft from

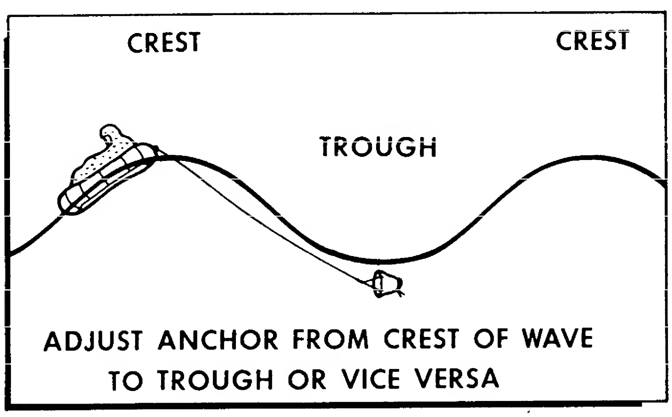


Figure 23-47. Deployment of the Sea Anchor.

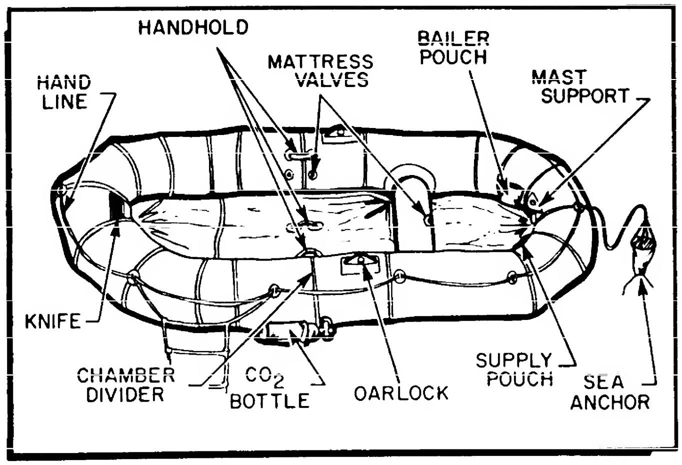


Figure 23-48. Seven-Man Raft.

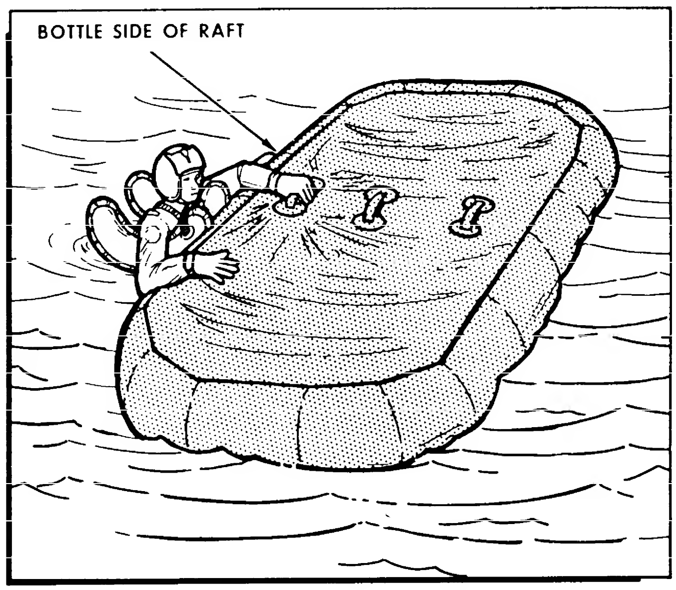


Figure 23-49. Method of Righting Raft.

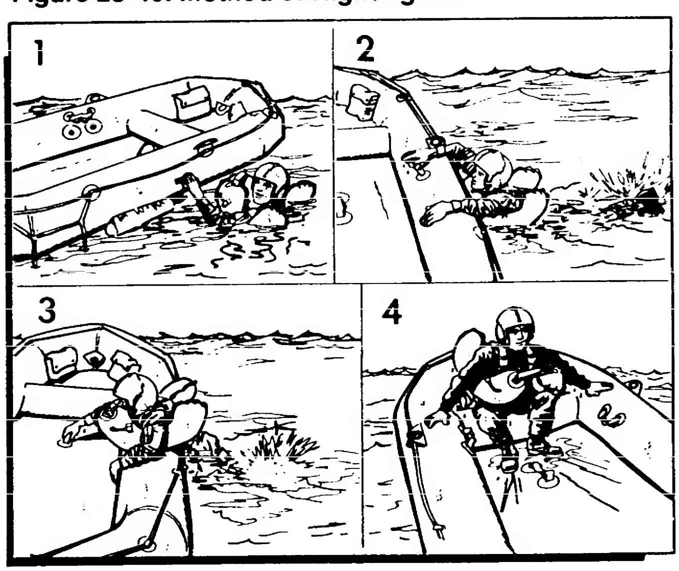


Figure 23-50. Method of Boarding Seven-Man Raft.

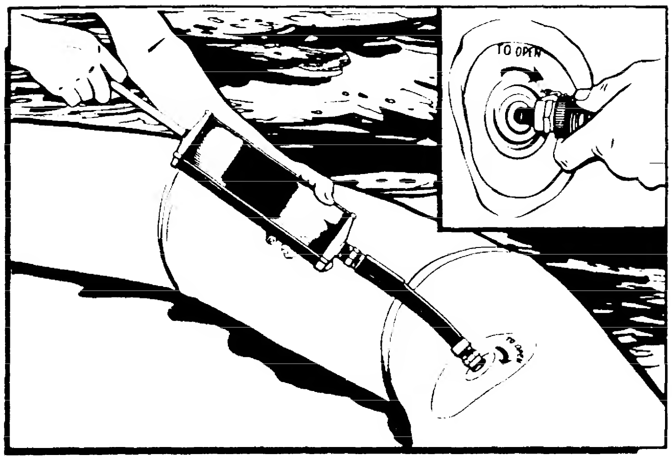


Figure 23-51. Inflating the Raft.

turning over. In rough weather, the sea anchor is kept out away from the bow. The passengers should sit low in the raft with their weight distributed to hold the upwind side down. They should also avoid sitting on the sides of the raft or standing up to prevent falling out. Sudden movements (without warning the other passengers) should be avoided. When the sea anchor is not in use, it should be tied to the raft and stowed in such a manner that it will hold immediately if the raft capsizes.

e. Twenty to Twenty Five-Man Rafts. The 20/25-man rafts may be found in multiplace aircraft (figures 23-53 and 23-54). They will be found in accessible areas of the fuselage or in raft compartments. Some may be automatically deployed from the cockpit, while others may need manual deployment. No matter how the raft lands in the water, it's ready for boarding. The accessory kit is attached by a lanyard and is retrieved by hand. The center chamber must be inflated manually with the hand pump. The 20/25-man raft should be boarded from the aircraft if possible; if not, the following steps should be taken:

(1) Approach lower boarding ramp.

(2) Separate the life preserver.

(3) Grasp the boarding handles and kick the legs to get the body into a prone position on the water's surface; then kick and pull until inside the raft.

(4) If for any reason the raft is not completely inflated, boarding will be made easier by approaching the intersection of the raft and ramp, grasping the upper boarding handle, and swinging one leg onto the center of the ramp as in mounting a horse (figure 23-55).

(5) The equalizer tube should be clamped immediately upon entering the raft to prevent deflating the entire raft, in case of puncture (figure 23-56).

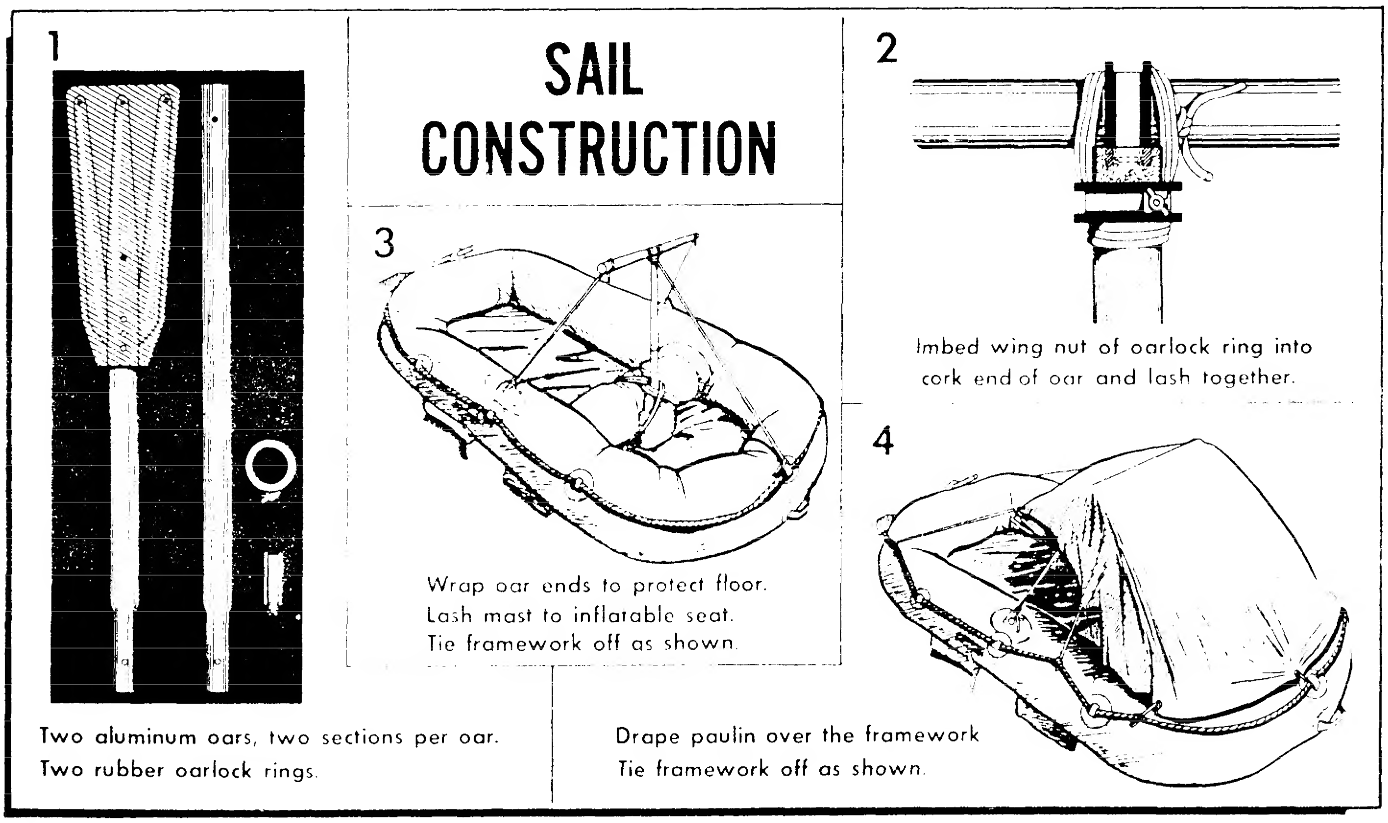


Figure 23-52. Sail Construction.

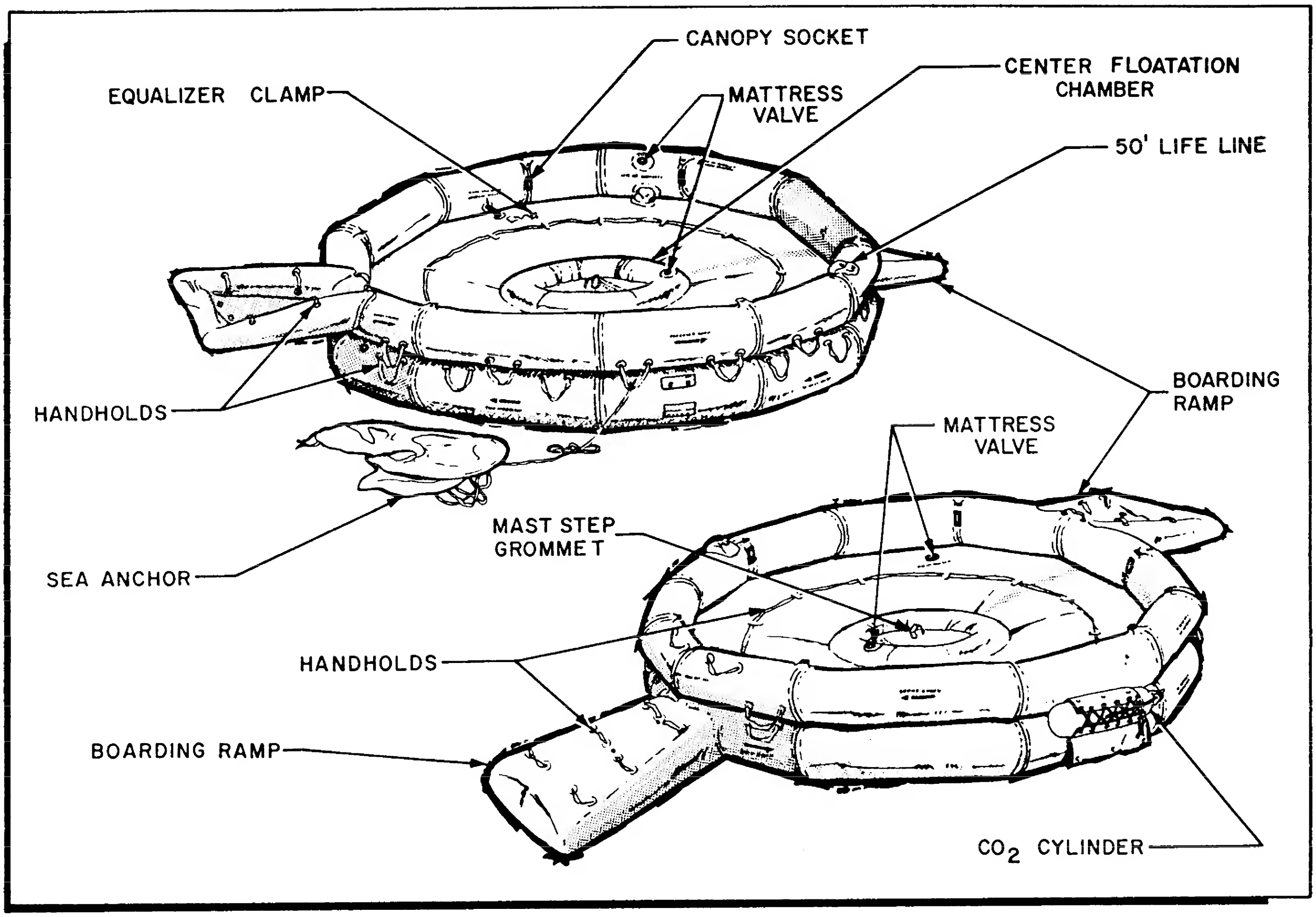


Figure 23-53. 20-Man Raft.

(6) The 20/25-man raft can be inflated by using the pump to keep the chambers and center ring firm. They should be well rounded but not drum tight (figure 23-57).

23-12. Making a Landfall. The lookout should watch carefully for signs of land. Some indications of land are:

a. A fixed cumulus cloud in a clear sky, or in a sky where all other clouds are moving, often hovers over or slightly downwind from an island.

b. In the tropics, a greenish tint in the sky is often caused by the reflection of sunlight from the shallow lagoons or shelves of coral reefs.

c. In the arctic, ice fields or snow-covered land are often indicated by light-colored reflections on clouds, quite different from the darkish gray reflection caused by open water.

d. Deep water is dark green or dark blue. Lighter color indicates shallow water, which may mean land is near.

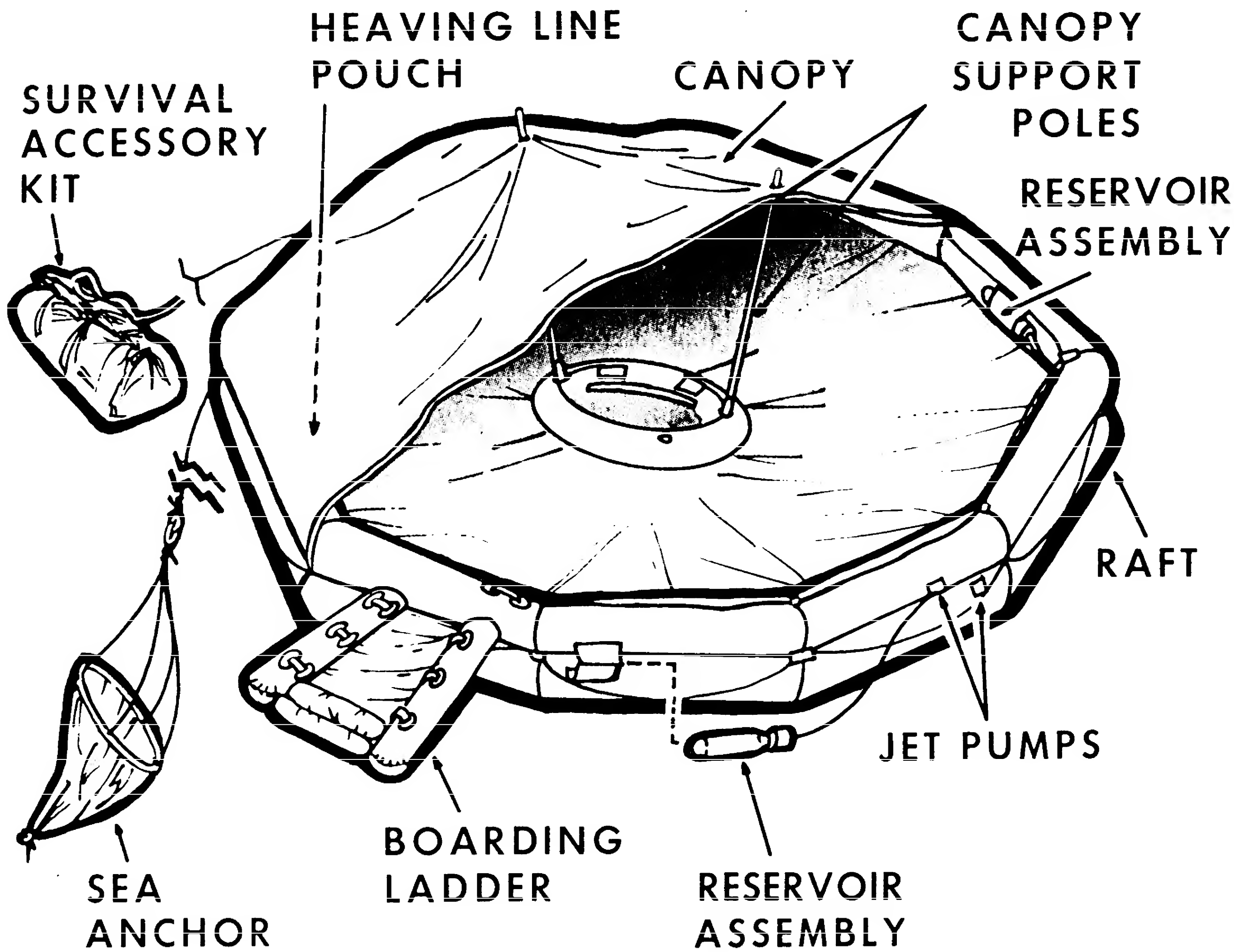
e. In fog, mist, rain, or at night, when drifting past a nearby shore, land may be detected by characteristic odors and sounds. The musty odor of mangrove swamps and mudflats and the smell of burning wood carries a long way. The roar of surf is heard long before the surf is seen. Continued cries of sea birds from one direction indicate their roosting place on nearby land.

f. Birds are usually more abundant near land than over the open sea. The direction from which flocks fly at dawn and to which they fly at dusk may indicate the direction of land. During the day, birds are searching for food and the direction of flight has no significance unless there is a storm approaching.

g. Land may be detected by the pattern of the waves, which are refracted as they approach land. Figure 23-58 shows the form the waves assume. Land should be located by observing this pattern and turning parallel to the slightly turbulent area marked "X" on the illustration and following its direction.

23-13. Methods of Getting Ashore:

a. Swimming Ashore. This is a most difficult decision. It depends on many things. Some good swimmers



- CHECK RAFT FOR INFLATION AND LEAKS
- BAIL OUT THE RAFT
- INVENTORY AND STOW ALL GEAR
- DEPLOY AND ADJUST SEA ANCHOR
- RIG SPRAY SHIELD FOR PROTECTION FROM THE ELEMENTS
- KEEP CALM, ESTIMATE YOUR SITUATION
- PREPARE FOR PICKUP

Figure 23-54. 25-Man Raft.

have been able to swim eight-tenths of a mile in 50°F water before being overcome by hypothermia. Others have not been able to swim 100 yards. Furthermore, distances on the water are very deceptive. In most instances, staying with the raft is the best course of action. If the decision is made to swim, a life preserver or other flotation aid should be used. Shoes and at least one thickness of clothing should be worn. The side or breast stroke will help conserve strength.

(1) If surf is moderate the survivor can ride in on the back of a small wave by swimming forward with it and making a shallow dive to end the ride just before the wave breaks. The swimmer should stay in the trough between waves in high surf, facing the seaward wave and submerging when the wave approaches. After the wave passes, the swimmer should work shoreward in the next trough.

(2) If the swimmer is caught in the undertow of a large wave, push off the bottom and swim to the surface and proceed shoreward. A place where the waves rush up onto the rocks should be selected if it is necessary to land on rocky shores and avoid places where the waves explode with a high white spray. After selecting the landing point, the swimmer should advance behind a

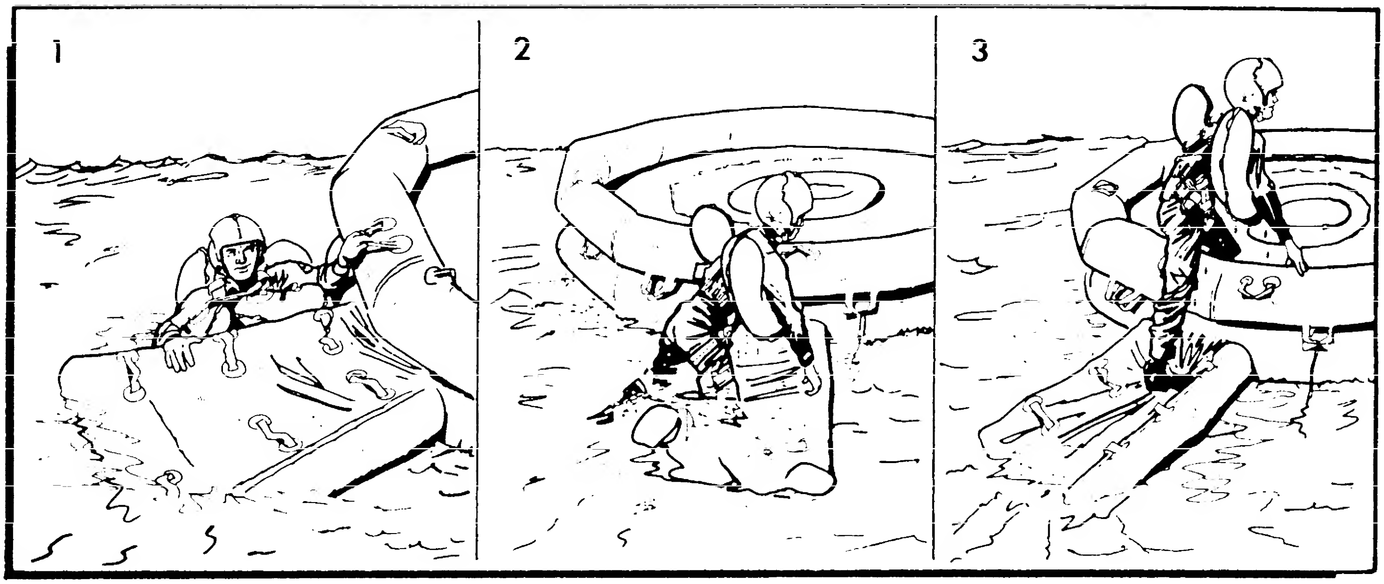


Figure 23-55. Boarding 20-Man Raft.

large wave into the breakers. The swimmer should face shoreward and take a sitting position with the feet in front, 2 or 3 feet lower than the head, so the knees are bent and the feet will absorb shocks when landing or striking submerged boulders or reefs. If the shore is not reached the first time, the survivor should swim with hands and arms only. As the next wave approaches, the sitting position with the feet forward should be repeated until a landing is made.

(3) Water is quieter in the lee of a heavy growth of seaweed. This growth can be very helpful. The swimmer should crawl over the top by grasping the vegetation with overhand movements.

(4) A rocky reef should be crossed in the same way as landing on a rocky shore. The feet should be close together with knees slightly bent in a relaxed sitting posture to cushion blows against coral.

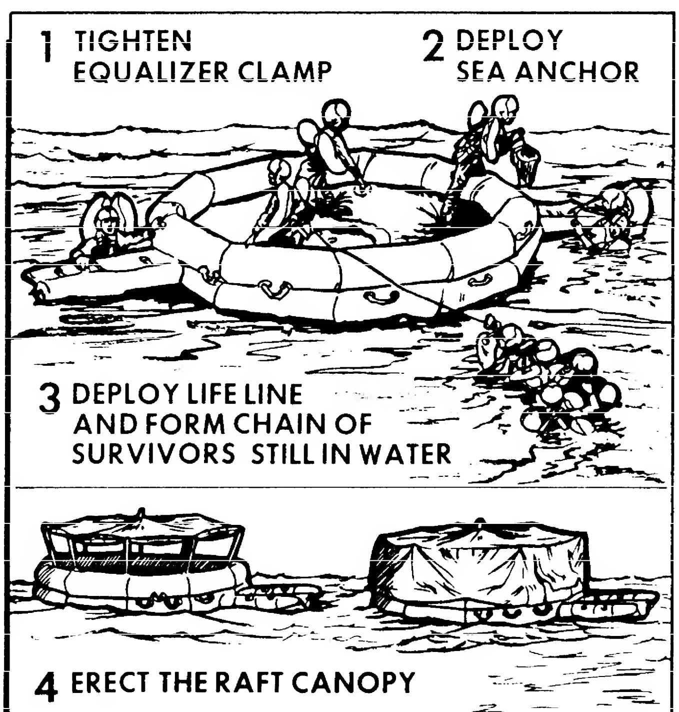


Figure 23-56. Immediate Action—Multiplace Raft.

b. Rafting Ashore. In most cases, the one-man raft can be used to make a shore landing with no danger. Going ashore in a strong surf is dangerous. The time should be taken to sail around and look for a sloping beach where the surf is gentle. The landing point should be carefully selected. Landing when the Sun is low and straight in front is not recommended. The survivor

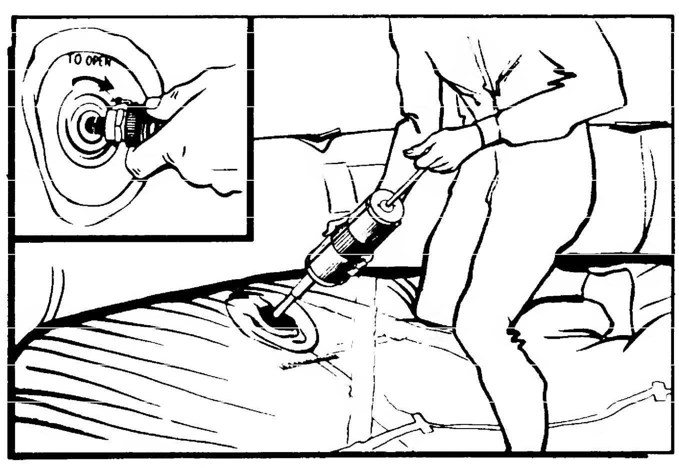


Figure 23-57. Inflating the 20-Man Raft.

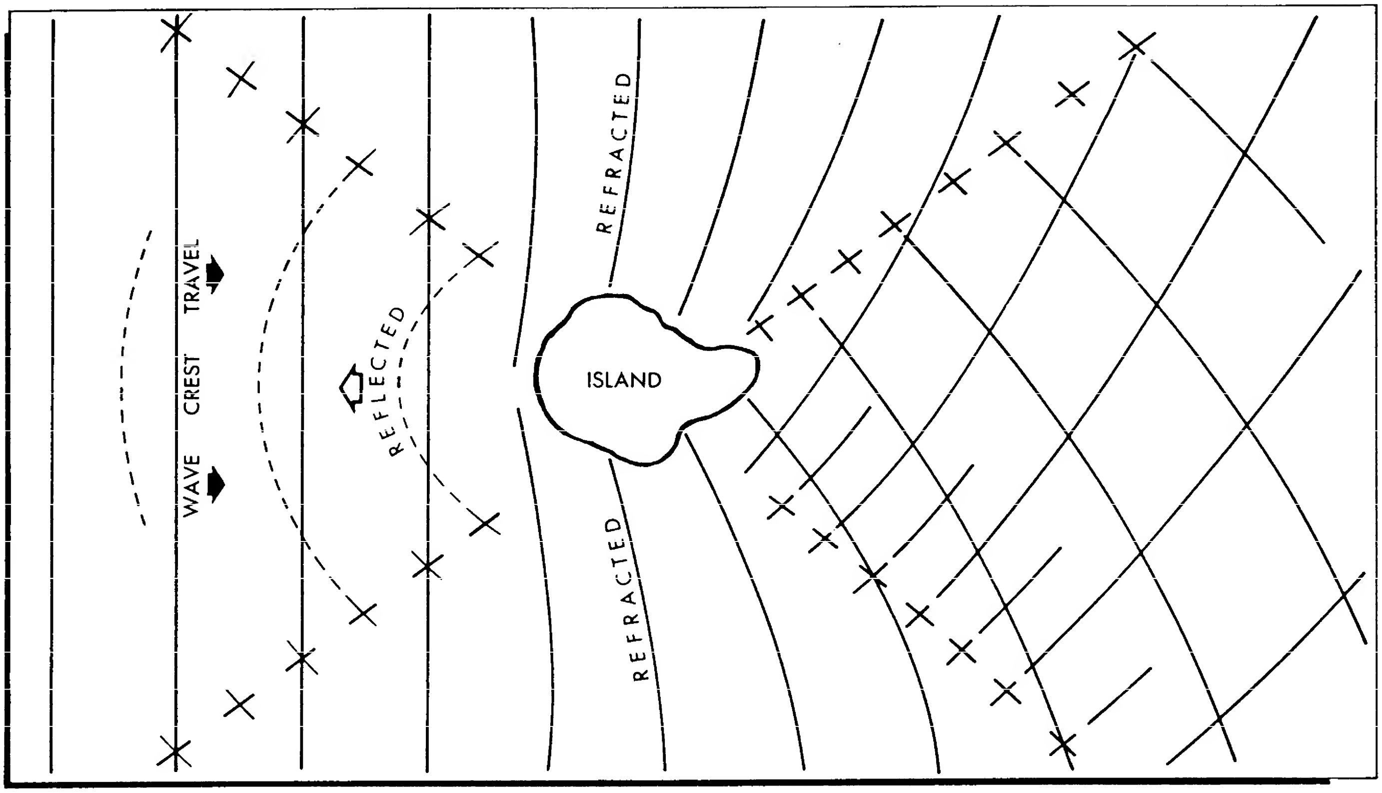


Figure 23-58. Diagram of Wave Patterns About an Island.

should look for gaps in the surf line and head for them while avoiding coral reefs and rocky cliffs. These reefs don't occur near the mouths of freshwater streams. Avoid rip currents or strong tidal currents which may carry the raft far out to sea.

(1) When going through surf, the survivor should:

(a) Take down the mast.
(b) Don clothing and shoes to avoid injuries.
(c) Adjust and fasten life preserver.
(d) Stow equipment.
(e) Use paddles to maintain control.

(f) Ensure the sea anchor is deployed to help prevent the sea from throwing the stern of the raft around and capsizing it. CAUTION: The sea anchor should not be deployed when traveling through coral.

(2) In medium surf with no wind, survivors should keep the raft from passing over a wave so rapidly that it drops suddenly after topping the crest. If the raft turns over in the surf, every effort should be made to grab hold.

(3) The survivor should ride the crest of a large wave as the raft nears the beach, staying inside until it has grounded. If there is a choice, a night landing should not be attempted. If signs of people are noted, it might be advantageous to wait for assistance.

(4) Sea-ice landings should be made on large stable floes only. Icebergs, small floes, and disintegrating floes could cause serious problems. The edge of the ice can cut, and the raft deflated. Use paddles and hands to keep the raft away from the sharp edges of the iceberg. The raft should be stored a considerable distance from the ice edge. It should be fully inflated and ready for use in case the floe breaks up.

Part Eight

SIGNALING AND RECOVERY

Chapter 24

SIGNALING

24-1. Introduction:

a. Most successful recoveries have resulted primarily because survivors were able to *assist* in their own recovery. Many rescue efforts failed because survivors lacked the knowledge and ability necessary to assist. When needed, this knowledge and ability could have made the difference between life or death—freedom or captivity (figure 24-1).

Figure 24-1. Signaling and Recovery.

b. What can survivors do to assist in their own recovery? First, they need to know what is being done to find them. Next, they need to know how to operate the communications equipment in the survival kit and when to put each item into use. Survivors should also be able to improvise signals to improve their chances of being sighted and to supplement the issued equipment.

c. It is not easy to spot one survivor, a group of survivors, or even an aircraft from the air, especially when visibility is limited. Emergency signaling equipment is designed to make a person easier to find. Emergency equipment may be used to provide rescue personnel with information about survivors' conditions, plans, position, or the availability of a rescue site where recovery vehicles might reach them (figure 24-2).

d. A part of a survivor's plan of action should be to visualize how emergencies will develop, recognize them, and, at the appropriate time, let friendly forces know about the problem. The length of time before survivors are rescued often depends on the effectiveness of emergency signals and the speed with which they can be used. Signal sites should be carefully selected. These sites should enhance the signal and have natural or manufactured materials readily available for immediate use. Survivors should avoid using pyrotechnic signals wastefully as they may be needed to enhance rescue efforts. Signals used correctly can hasten recovery and eliminate the possibility of a long, hard survival episode. Survivors should:

(1) Know how to use their emergency signals.

(2) Know when to use their signal.

Figure 24-2. Signaling.

(3) Be able to use their signals on short notice.

(4) Use signals in a manner which will not jeopardize individual safety.

e. The situation on the ground governs the type of information which survivors can furnish the rescue team, and will govern the type of signaling they should use. In nontactical survival situations, there are no limitations on the ways and means survivors may use to furnish information.

f. In hostile areas, limitations on the use of signals should be expected. The use of some signaling devices will pinpoint survivors to the enemy as well as to friendly personnel. Remember the signal enhances the visibility of the survivors.

24-2. Manufactured Signals:

a. Electronic Signals:

(1) Current line-of-sight electronic signaling devices fall into two categories. One is the transceiver type; the other is the personal locator beacon type. The transceiver type is equipped for transmitting tone or voice and receiving tone or voice. The personal locator beacon is equipped to transmit tone only. The ranges of the different radios vary depending on the altitude of the receiving aircraft, terrain factors, forest density, weather, battery strength, type(s) of radios and interference. Interference is a very important aspect of the use of these radios. If a personal locator beacon is transmitting, it will interfere with incoming and outgoing signals of the transceivers.

(2) Before using survival radios, a few basic precautions should be observed. These will help in obtaining maximum performance from the radios in survival situations.

(a) The survival radios are line-of-sight communication devices; therefore, the best transmission range will be obtained when operating in clear, unobstructed terrain.

(b) Extending from the top and bottom of the radio antenna is an area referred to as the "cone of silence." To avoid the "cone of silence" problem, keep the radio/beacon antenna orthogonal to (at a right angle to) the path of the rescue aircraft.

(c) Since the radios have the capability of transmitting a tone (beacon) without being hand-held, they can be placed upright on a flat elevated surface allowing the operator to perform other tasks.

(d) Never allow the radio antenna to ground itself on clothing, body, foliage or the ground. This will severely decrease the effective range of the signals.

(e) Conserve battery power by turning the radio off when not in use. Do not transmit or receive constantly. Use the locator beacon to supplement the radio when transmitting is done. In tactical environments, the radio should be used as stated in the premission briefing.

(f) Survival radios are designed to operate in extreme heat or cold. The life expectancy of a battery decreases as the temperature drops below freezing and exposure to extreme heat or shorting out of the battery can cause an explosion. During cold weather, the battery should be kept warm by placing it between the layers of clothing to absorb body heat, or wrapped in some type of protective material when it is not being used.

(g) Survival radios are designed to be waterproof. However, precautions should be taken to keep them out of water.

(3) Presently, a satellite monitoring system has been developed to assist in locating survivors. To activate this system (SARSAT), the transmitter is "keyed" for a minimum of 30 seconds. In a nontactical situation, leave the beacon on until rescue is heard or sighted.

b. Pyrotechnics. Care should be used when operating around flammable materials.

(1) A device containing chemicals for producing smoke or light is known as a pyrotechnic. Hand-held flares are in this category. Survivors may be required to use a variety of flares. They must know the types of flares stored in their survival kits and (or) aircraft. Aircrew members should learn how to use each type of flare before they face an emergency. Flares are designed to be used during the day or night. Day flares produce a unique bright-colored smoke which stands out very clearly against most backgrounds. Night flares are extremely bright and may be seen for miles by air, ground, or naval recovery forces.

(2) The hand-held launched flares also fall in the pyrotechnic category. They were designed to overcome the problems of terrain masking and climatic conditions. For example, a person may be faced with multilayer vegetation or atmospheric conditions known as an inversion which keeps the smoke next to the ground.

(3) Flares must be fired at the right time to be of maximum use. Smoke flares, for example, take a second or two after activation before they produce a full volume of smoke. Therefore, the flare should be ignited just before the time it can be seen by rescue personnel. These signals should not be used in tactical environments unless directed to do so.

(4) Tracer ammunition is another pyrotechnic which may be issued to aircrew members. When fired, the projectile appears as an orange-red flash the size of a golf ball. According to specifications, these tracers have a range of 1,300 feet. Tracer bullets have been detected from a distance of 6 miles, but there is usually difficulty in pinpointing the survivor. A survivor should only use

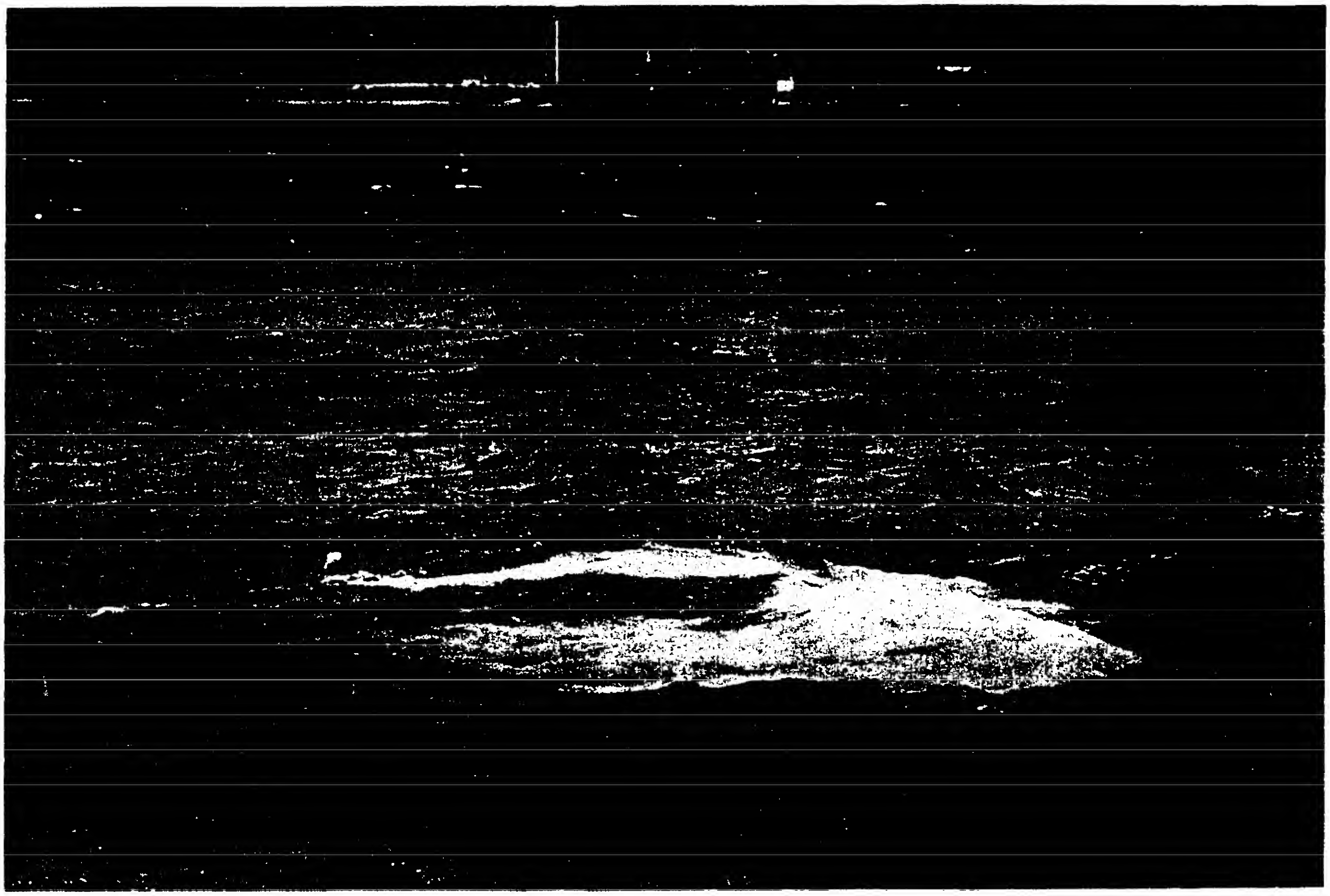


Figure 24-3. Sea Marker Dye.

this signaling device when rescue forces can be seen or heard. Do not direct this device *at* the aircraft.

(5) Because of the rapid changing technology in pyrotechnic signaling devices, an aircrew member should check regularly for new and improved models, making special note of the firing procedures and safety precautions necessary for their operations.

c. Sea Marker:

(1) Of the many dyes and metallic powders tested at various times for marking the sea, the most successful is the fluorescent, water-soluble, orange powder. When released in the sea, a highly visible, light green, fluorescent cast is produced. Sea marker dye has rapid dispersion power; a packet spreads into a slick about 150 feet in diameter and lasts an hour or more in calm weather. Rough seas will stream it into a long streak, which may disperse in 20 minutes (figure 24-3).

(2) Under ideal weather conditions, the dye can be sighted at 5 miles with the aircraft operating at 1,000 feet. The dye has also been spotted at 7 miles away from an aircraft operating at 2,000 feet.

(3) Sea marker dye should be used in friendly areas during daytime and only when there is a chance of being sighted (aircraft seen or heard in the immediate area). It is not effective in heavy fog, solid overcast and storms with high winds and waves. The release tab on the packet of dye is pulled to open for use. In calm water, the dye can be dispersed more rapidly stirring the water with paddles or hands.

(4) If left open in the raft, the escaping powder penetrates clothing, stains hands, face, and hair, and eventually may contaminate food and water. To avoid the inevitable messiness, some survivors have tied the sea marker dye to the sea anchor. Others have dipped the packet over the side, letting it drain off the side into the sea. After using the dye, it should be rewrapped to conserve the remainder of the packet.

d. Paulin Signals. The paulin is a conventional signaling device used to send specific messages to aircraft. It may be packed with some sustenance kits and multiplace liferaft accessory kits. The paulin is constructed of rubberized nylon material and is blue on one side and yellow on the other. These colors contrast against each

other so when one side is folded over the other, the designs are easily distinguished (figure 24-4). The size is 7 feet by 11 feet which is a disadvantage when folded because it makes a small signal. The paulin has numerous uses. It can be used as a camouflage cloth, sunshade, tent, or sail, or it can be used to catch drinking water. The space blanket, used as a substitute for the sleeping bag in some survival kits, can be used in the same manner as the signal paulin because it is highly reflective (silver on one side and various colors on the other side).

e. Audio Signals. Sounds carry far over water under ideal conditions; however, they are easily distorted and deadened by the wind, rain, or snow. On land, heavy foliage cuts down on the distance sound will travel. Shouting and whistling signals have been effective at short ranges for summoning rescue forces. Most contacts using these means were made at less than 200 yards, although a few reports claim success at ranges of up to a mile. A weapon can be used to attract attention by firing shots in a series of three. The number of available rounds determine whether this is practical. Survivors have used a multitude of devices to produce sound. Some examples are: striking two poles together, striking one pole against a hollow tree or log, and improvising whistles out of wood, metal, and grass.

f. Light Signals. When tested away from other manufactured lights, aircraft lights have been seen up to 85 miles. At night, a survivor should use any type of light to attract attention. A signal with a flashlight, or a light or fire in a parachute shelter, can be seen from a long distance. A flashing light (strobelight) is in most survival kits.

g. Signal Mirror.

(1) The signal mirror is probably the most underrated signaling device found in the survival kit. It is the most valuable daytime means of visual signaling. A mirror flash has been visible up to 100 miles under ideal conditions, but its value is significantly decreased unless it is used correctly. It also works on overcast days. Practice is the key to effective use of the signal mirror. Whether the mirror is factory manufactured or improvised, aim it so the beam of light reflected from its surface hits the overflying aircraft.

(2) The signal mirror's effectiveness is its greatest weakness if the survivor is in enemy territory. It is just as bright to the enemy as to the rescuer; use it wisely! Survivors should understand that even if the mirror flash is directly on the aircraft (especially if the aircraft is using terrain masking techniques), that same flash may be visible to others (possibly the enemy) who are located at the proper angle in regard to the survivors' position.

(3) In a hostile environment, the exact location of the flash is extremely important. The signal mirror should be covered when not in use. One of the easiest

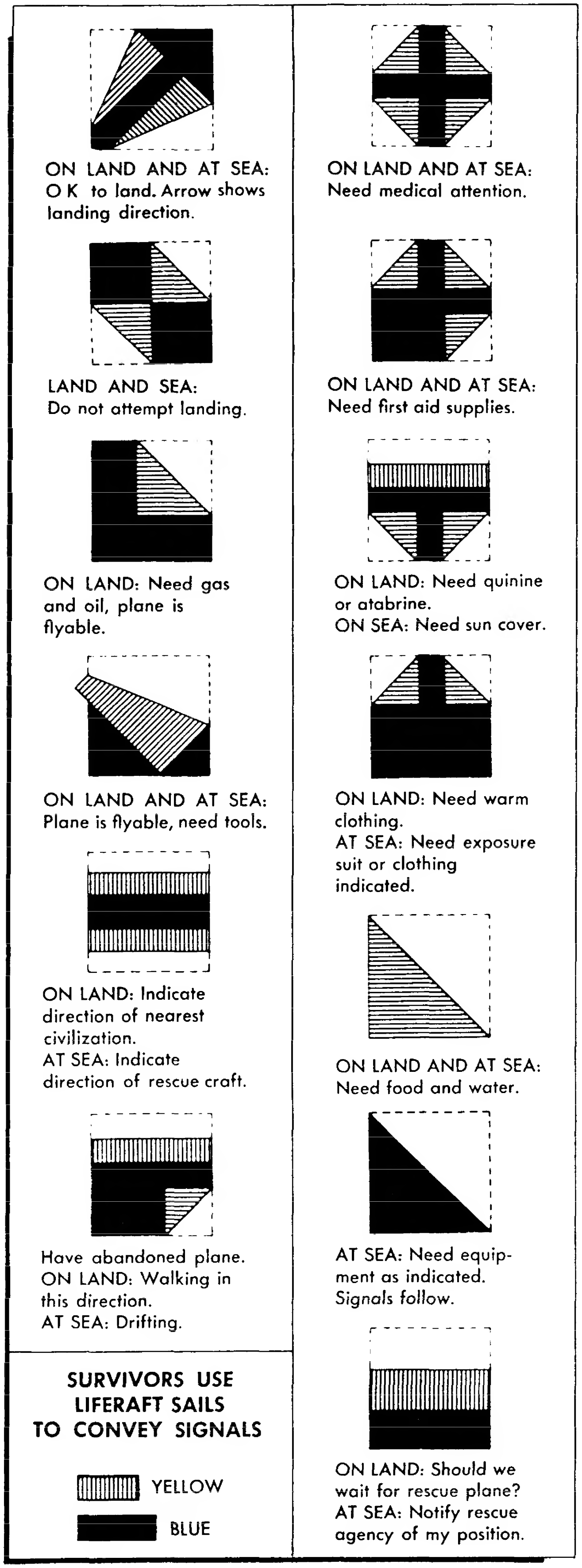


Figure 24-4. Paulin Signals.

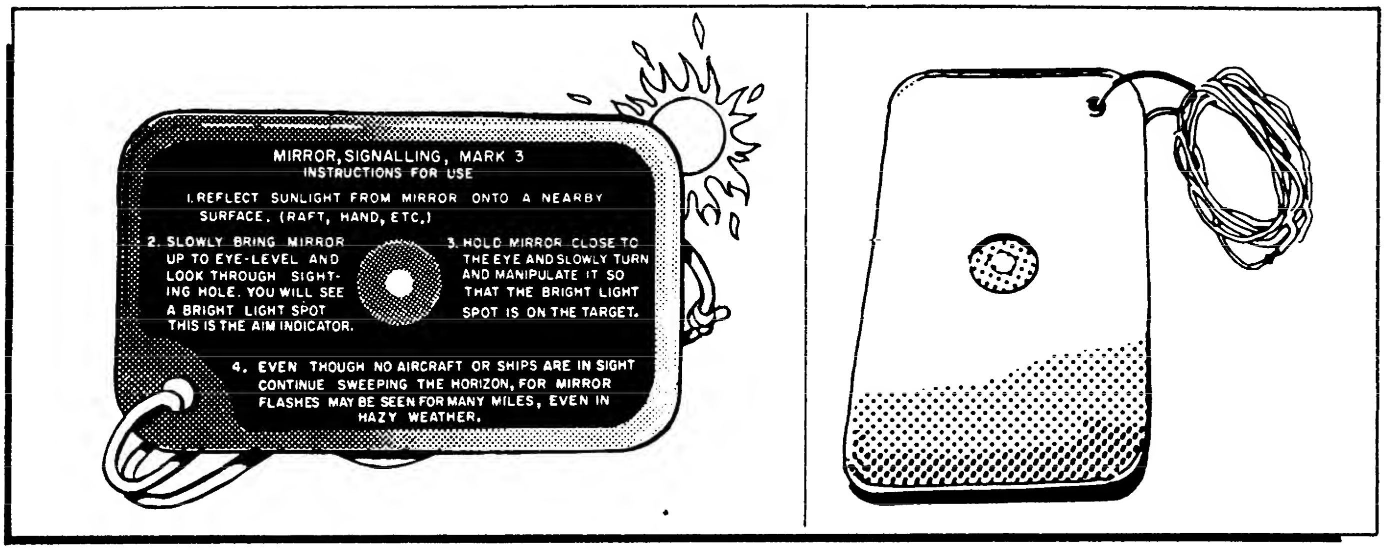


Figure 24-5. Signal Mirrors.

methods is to tie the string from the mirror around the neck and tuck the mirror in the shirt or flight suit. When the mirror is removed from inside the clothing, the hand should be placed over the mirror surface to prevent accidental flashing. The covered mirror may then be raised toward the sky and the hand withdrawn. The flash can then be directed onto the free hand and the aiming indicator (sunspot) located. This minimizes the indiscriminate flashing of surrounding terrain. When putting the mirror away, the survivor should remember to cover the mirror to prevent a flash.

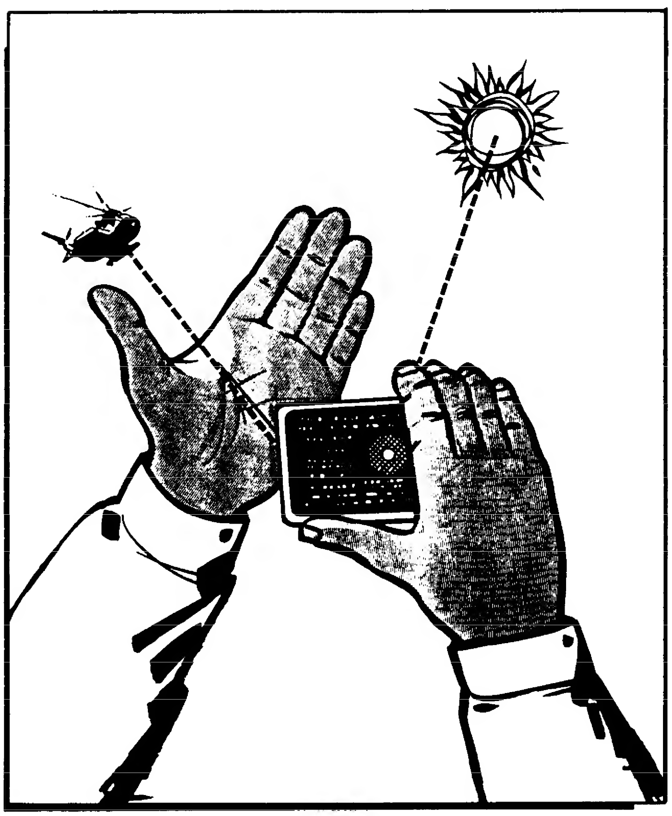


Figure 24-6. Aiming Signal Mirror.

h. Aiming Manufactured Mirrors. Instructions are printed on the back of the mirror. Survivors should:

(1) Reflect sunlight from the mirror onto a nearby surface—raft, hand, etc.

(2) Slowly bring the mirror up to eye-level and look through the sighting hole where a bright spot of light will be seen. This is the aim indicator.

(3) Hold mirror near the eye and slowly turn and manipulate it so the bright spot of light is on the target.

(4) In friendly areas, where rescue by friendly forces is anticipated, free use of the mirror is recommended. Survivors should continue to sweep the horizon even though no aircraft or ships are in sight (figure 24-5).

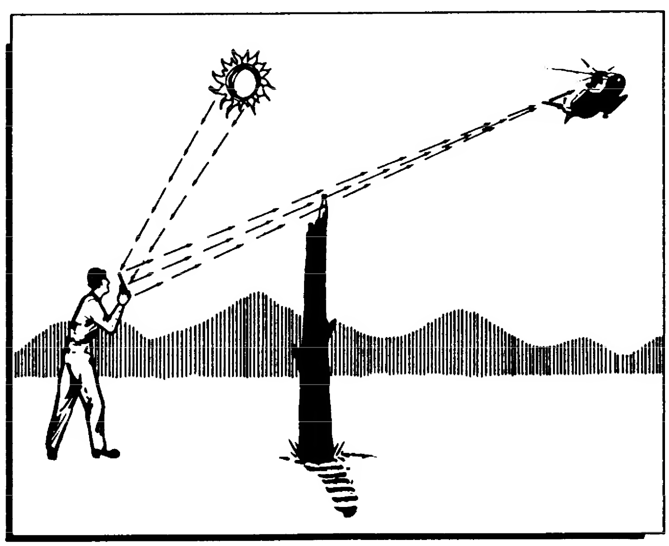


Figure 24-7. Aiming Signal Mirror-Stationary Object.

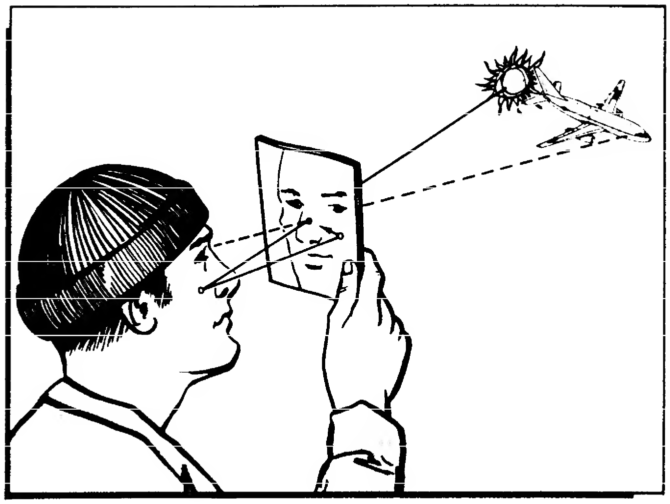


Figure 24-8. Aiming Signal Mirror—Double-Faced Mirror.

24-3. Improvised Signals:

a. Signal Mirrors. Improvised signal mirrors can be made from ration tins, parts from an aircraft, polished aluminum, glass, or the foil from rations or cigarette packs. However, the mirror must be accurately aimed if the reflection of the Sun in the mirror is to be seen by the pilot of a passing aircraft or the crew of a ship.

b. Aiming Improvised Mirrors:

(1) The simple way to aim an improvised mirror is to place one hand out in front of the mirror at arm's length and form a "V" with two fingers. With the target in the "V" the mirror can be manipulated so that the majority of light reflected passes through the "V" (figure 24-6). This method can be used with all mirrors. Another method is to use an aiming stake as shown in figure 24-7. Any object 4 to 5 feet high can serve as the point of reference.

(2) Survivors should hold the mirror so they can sight along its upper edge. Changing their position until the top of the stick and target line up, they should adjust the angle of the mirror until the beam of reflected light hits the top of the stick. If stick and target are then kept in the sighting line, the reflection will be visible to the rescue vehicle.

(3) Another method is to improvise a double-faced mirror (shiny on both sides). A sighting hole can be made in the center of the mirror.

(a) When trying to attract the attention of a friendly rescue vehicle that is no more than 90 degrees from the Sun, proceed as shown in figure 24-8.

(b) The survivor's first step will be to hold the double-faced mirror about 3 to 6 inches away from the face and sight at the rescue target through the hole in the center of the mirror. The light from the Sun shining through the hole will form a spot of light on the survivor's face. This spot will be reflected in the rear surface of the mirror. Then, aiming at the rescue vehicle through the hole, the survivor can adjust the angle of the mirror until the reflection of the spot on the face in the rear surface of the mirror lines up with, and disappears, into the sighting hole.

(c) When the reflected spot disappears and the rescue vehicle is still visible through the hole, the survivor can be sure the reflected light from the Sun is accurately aimed. The survivor may also "shimmer" the mirror by moving it rapidly over the target. This ensures that the part of the bright flash the rescuers see coincides with the position of the survivor. This (shimmering) is especially useful on a moving target.

(d) When the angle between the target and the Sun is more than 90 degrees (when the survivor is between the rescue vehicle and the Sun) a different method may be used for aiming. The survivor should adjust the angle of the mirror until the spot made by the

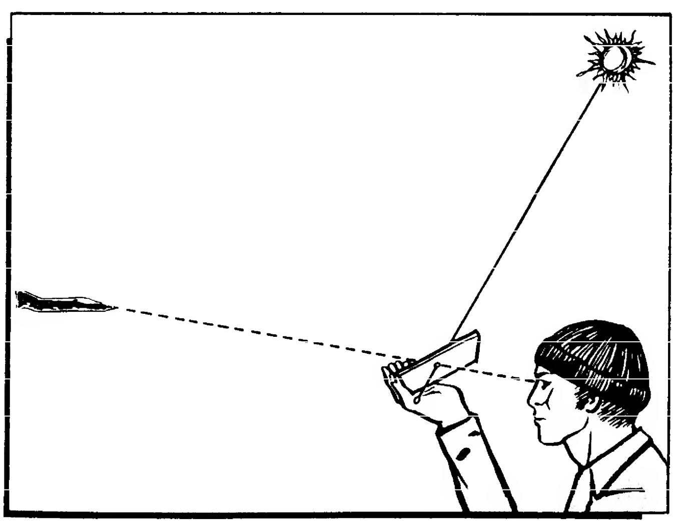


Figure 24-9. Aiming Signal Mirror—Angle Greater than 180 Degrees.

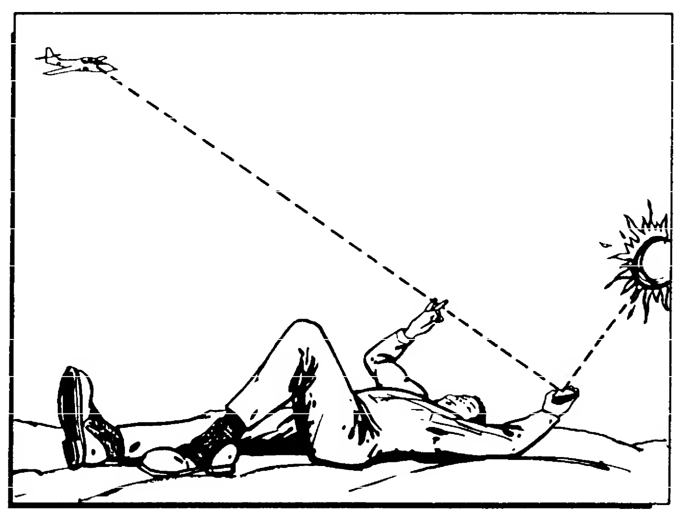


Figure 24-10. Aiming Signal Mirror—Angle Greater than 180 Degrees (Another Method).

Figure 24-11. Shelter as a Signal.

Sun's rays passing through the hole in the mirror lands on the hand instead of on the face. The reflection in the back of the mirror that comes off the hand may then be manipulated in the same way (figure 24-9).

(e) Another method used when the angle is greater than 90 degrees is to lie on the ground in a large clearing and aim the mirror using one of the methods previously discussed (figure 24-10).

c. Fire and Smoke Signals:

(1) Fire and smoke can be used to attract the attention of recovery forces. Three evenly spaced fires, 100 feet apart, arranged in a triangle or in a straight line, serve as an international distress signal. One signal fire will usually work for a survivor. During the night, the flames should be as bright as possible, and during the day, as much smoke as possible should be produced.

(2) Smoke signals are most effective on clear and calm days. They have been sighted from up to 50 miles away. High winds, rain, or snow tend to disperse the smoke and lessen the chances of it being seen. Smoke signals are not dependable when used in heavily wooded areas.

(3) The smoke produced should contrast with its background. Against snow, dark smoke is most effective. Likewise, against a dark background, white smoke is best. Smoke can be darkened by rags soaked in oil, pieces of rubber, matting, or electrical insulation, or plastic being added to the fire. Green leaves, moss, ferns, or water produce white smoke.

(4) To increase its effectiveness, the signal fire must be prepared before the recovery vehicle enters the area.

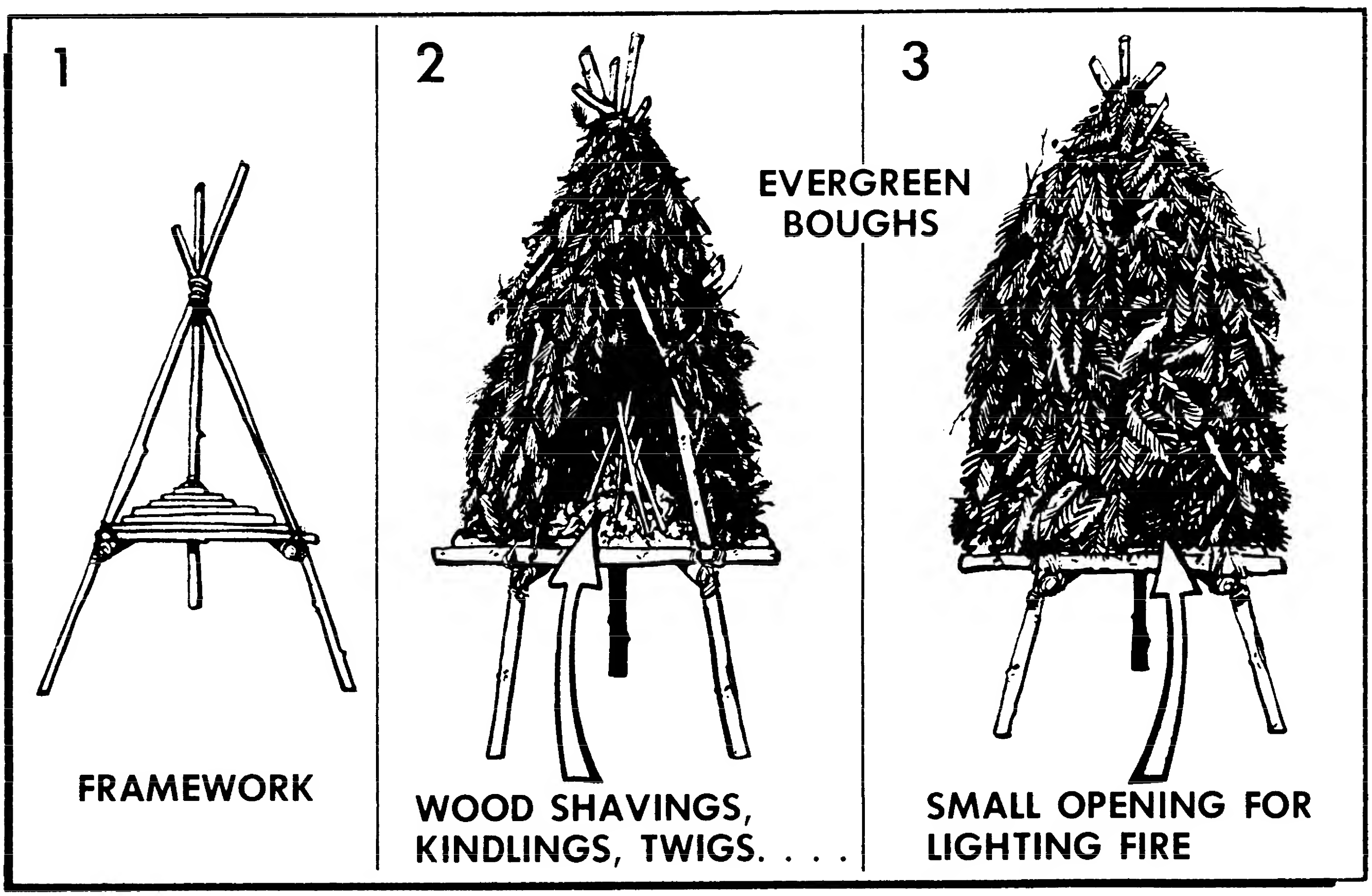


Figure 24-12. Smoke Generator—Platform.

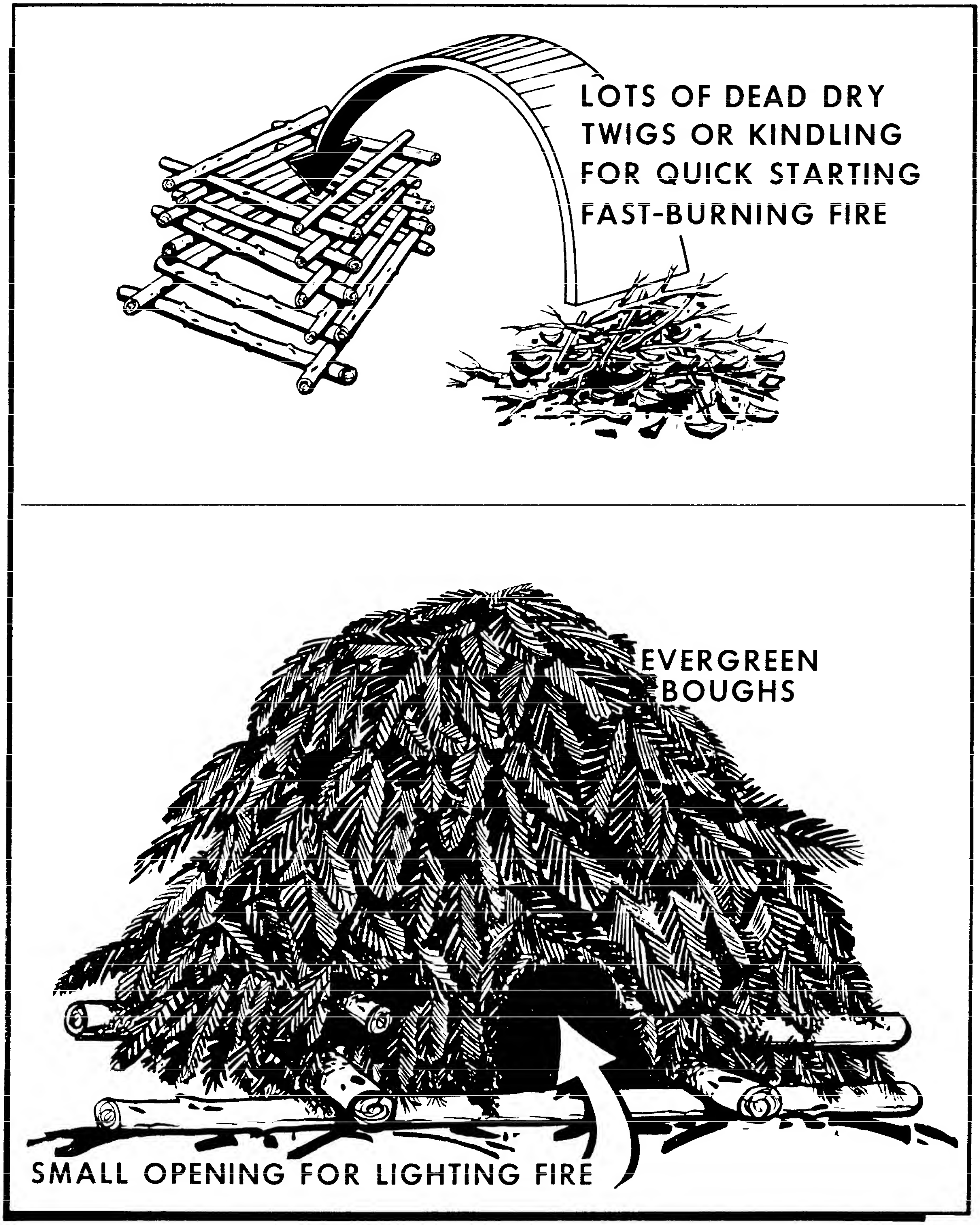


Figure 24-13. Smoke Generator—Ground.

The fires used by survivors for heat and cooking may be used as signal fires as long as the necessary materials are available in the immediate vicinity. Survivors should supplement the fire to provide the desired signal (figure 24-11).

(5) Smoke Generators:

(a) Raised Platform Generator (figure 24-12). The survivor should:

-1. Build a raised platform above wet ground or snow.

-2. Place highly combustible materials on the platform.

-3. Then place smoke-producing materials over the platform and light when search aircraft is in the immediate vicinity.

(b) Ground Smoke Generator (figure 24-13). The survivor should:

-1. Build a large log cabin fire configuration on the ground. This provides good ventilation and supports the green boughs used for producing smoke.

-2. Place smoke-producing materials over the fire lay; ignite when a search aircraft is in the immediate vicinity.

(c) Tree Torch Smoke Generator (figure 24-14). To build this device, the survivor should:

-1. Locate a tree in a clearing to prevent a forest fire hazard.

-2. Add additional smoke-producing materials.

-3. Add igniter.

-4. Light when a search aircraft is in the immediate vicinity.

(d) Fuel Smoke Generator. If survivors are with the aircraft, they can improvise a generator by burning aircraft fuels, lubricating oil, or a mixture of both. One to 2 inches of sand or fine gravel should be placed in the bottom of a container and saturated with fuel. Care should be used when lighting the fuel as an explosion may occur initially. If there is no container available, a hole can be dug in the ground, filled with sand or gravel, saturated with fuel, and ignited. Care should be taken to protect the hands and face.

d. Pattern Signals. The construction and use of pattern signals must take many factors into account. Size, ratio, angularity, contrast, location, and meaning are each important if the survivors' signals are to be effec-

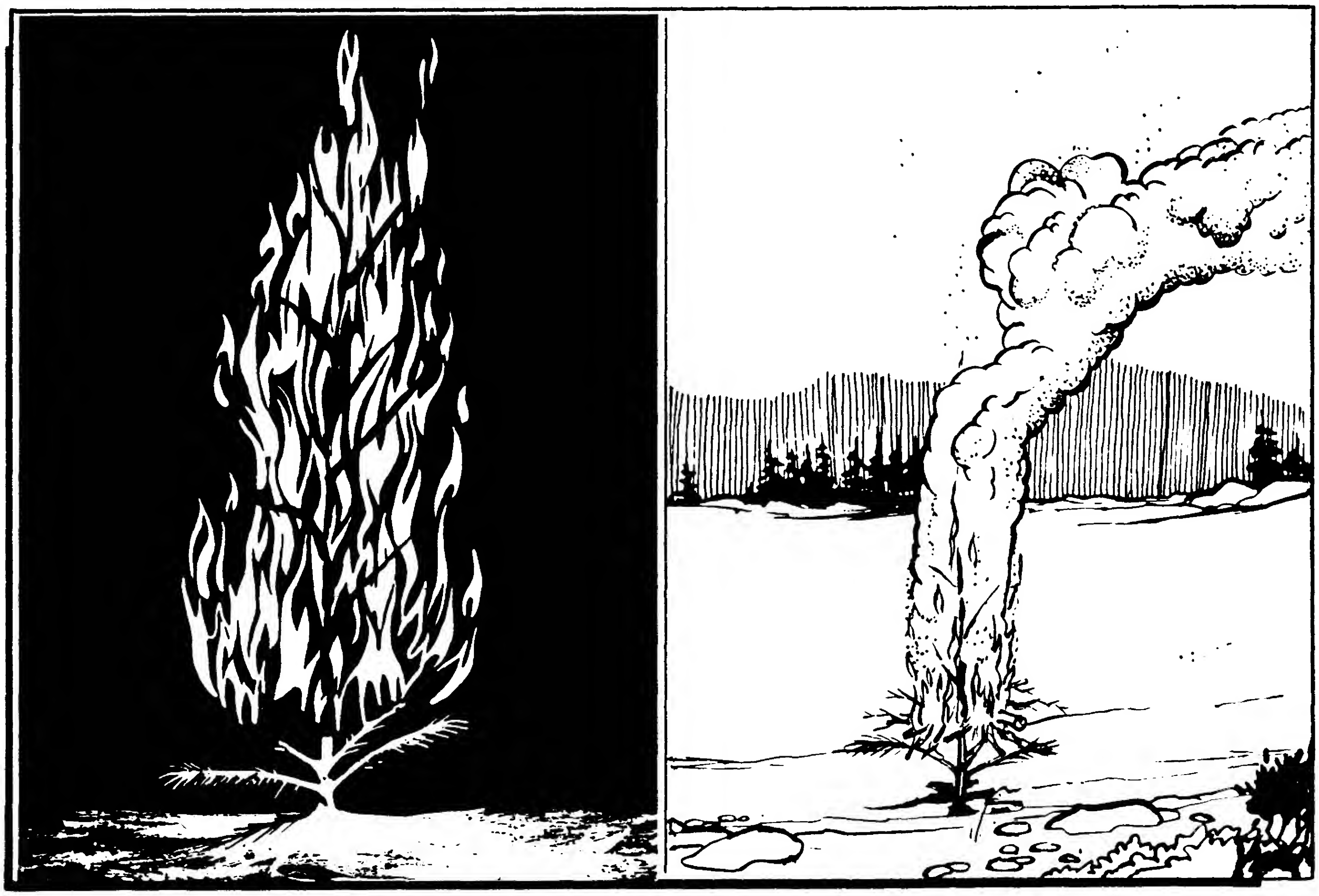


Figure 24-14. Tree Torch.

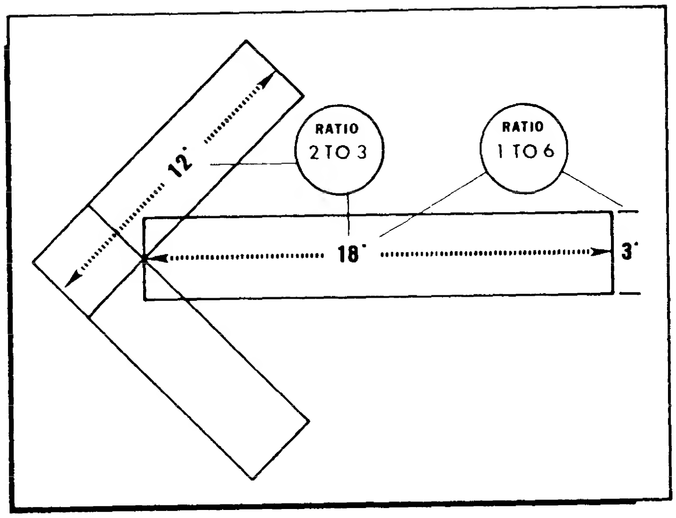


Figure 24-15. Pattern Signal Sizes.

tive. The type of signal constructed will depend on the material available to survivors. Not every crewmember will have a parachute, so ingenuity plays an important role in the construction of the signal. Survivors should remember to judge their signals from the standpoint of aircrew members who are flying over their location searching for them.

(1) Size. The signal should be as large as possible. To be most effective, the signal should have "lines" no less than 3 feet wide and 18 feet long (1:6) (figure 24-15).

(2) Ratio. Proper proportion should also be remembered. For example, if the baseline of an "L" is 18 feet long, then the vertical line of the "L" must be longer (27 feet), a 2 to 3 ratio, to keep the letter in proper proportion.

(3) Angularity. Straight lines and square corners are not found in nature. For this reason, survivors should make all pattern signals with straight lines and square corners.

(4) Contrast. The signal should stand out sharply against the background. The idea is to make the signal look "larger." On snow, the fluorescent sea dye available in the liferaft accessory kit can be used to add contrast around the signal. The survivor should do everything

Figure 24-16. Contrast (Snow).

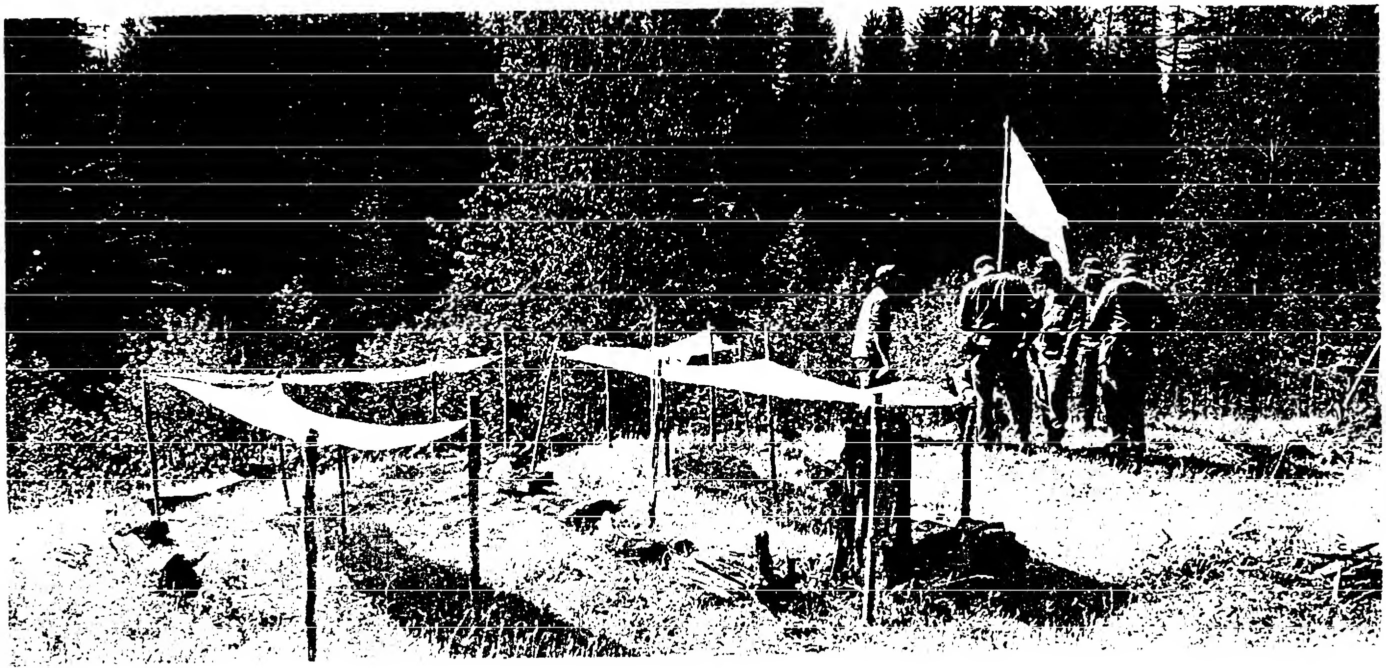


Figure 24-17. Contrast.

Figure 24-18. Location.

NO.	MESSAGE	CODE SYMBOL
1	REQUIRE ASSISTANCE	V
2	REQUIRE MEDICAL ASSISTANCE	X
3	NO or NEGATIVE	N
4	YES or AFFIRMATIVE	Y
5	PROCEEDING IN THIS DIRECTION	↑

Figure 24-19. Signal Key.

possible to disturb the natural look of the ground. In grass and scrubland, the grass should be stamped down or turned over to allow the signal to be easily seen from the air. A burned grass pattern is also effective. When in snow, a trampled out signal is very effective. Survivors should use only one path to and from the signal to avoid

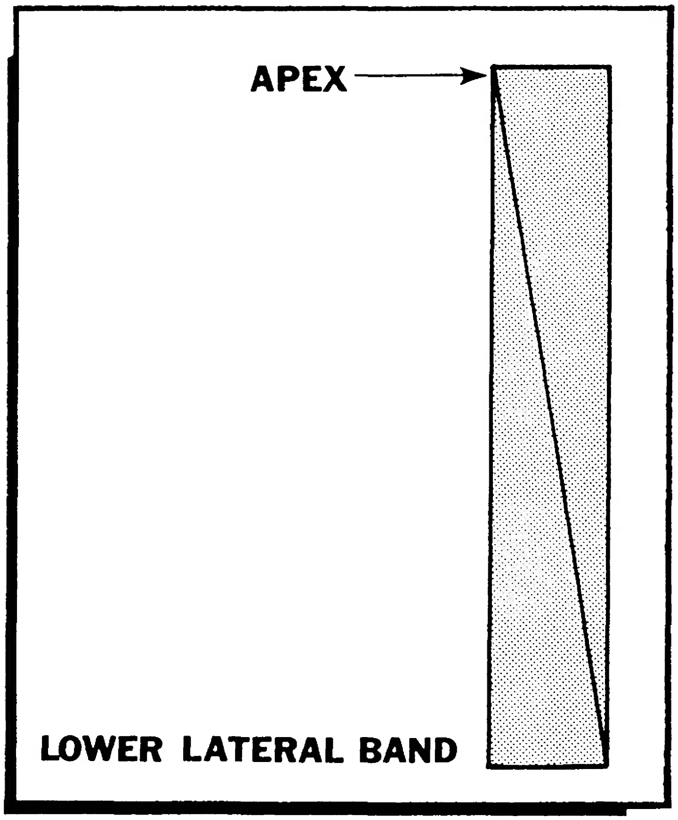


Figure 24-20. Parachute Strips.

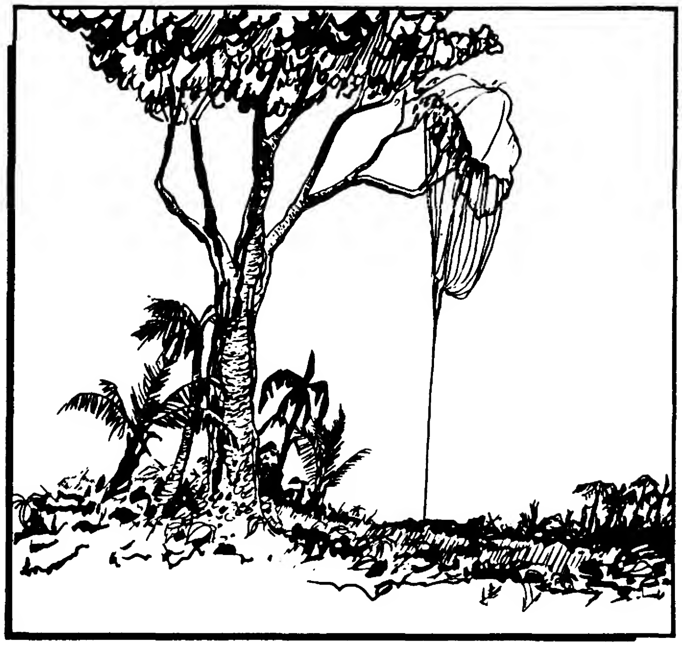


Figure 24-21. Parachute in Tree.

disrupting the signal pattern. Avoid using orange parachute material on a green or brown background as it has a tendency to blend in (figure 24-16). Contrast can be improved by outlining the signal with green boughs, piling brush and rocks to produce shadows, or raising the panel on sticks to cast its own shadow (figure 24-17).

(5) Location. The signal should be located so it can be seen from all directions. Survivors should make sure the signal is located away from shadows and overhangs. A large high open area is preferable. It can serve a dual function—one for signaling and the other for rescue aircraft to land (figure 24-18).

(6) Meaning. If possible, the signal should tell the rescue forces something pertaining to the situation. For example: "require medical assistance," or a coded symbol used during evasion, etc. Figure 24-19 shows the internationally accepted symbols.

e. Parachute Signals:

(1) Parachute material can be used effectively to construct pattern signals. A rectangular section of parachute material can be formed as shown in figure 24-20. When making a pattern signal, survivors should ensure the edges are staked down so the wind will not blow the panels away.

(2) A parachute caught in a tree will also serve as a signal. Survivors should try to spread the material over the tree to provide the maximum amount of signal (figure 24-21).

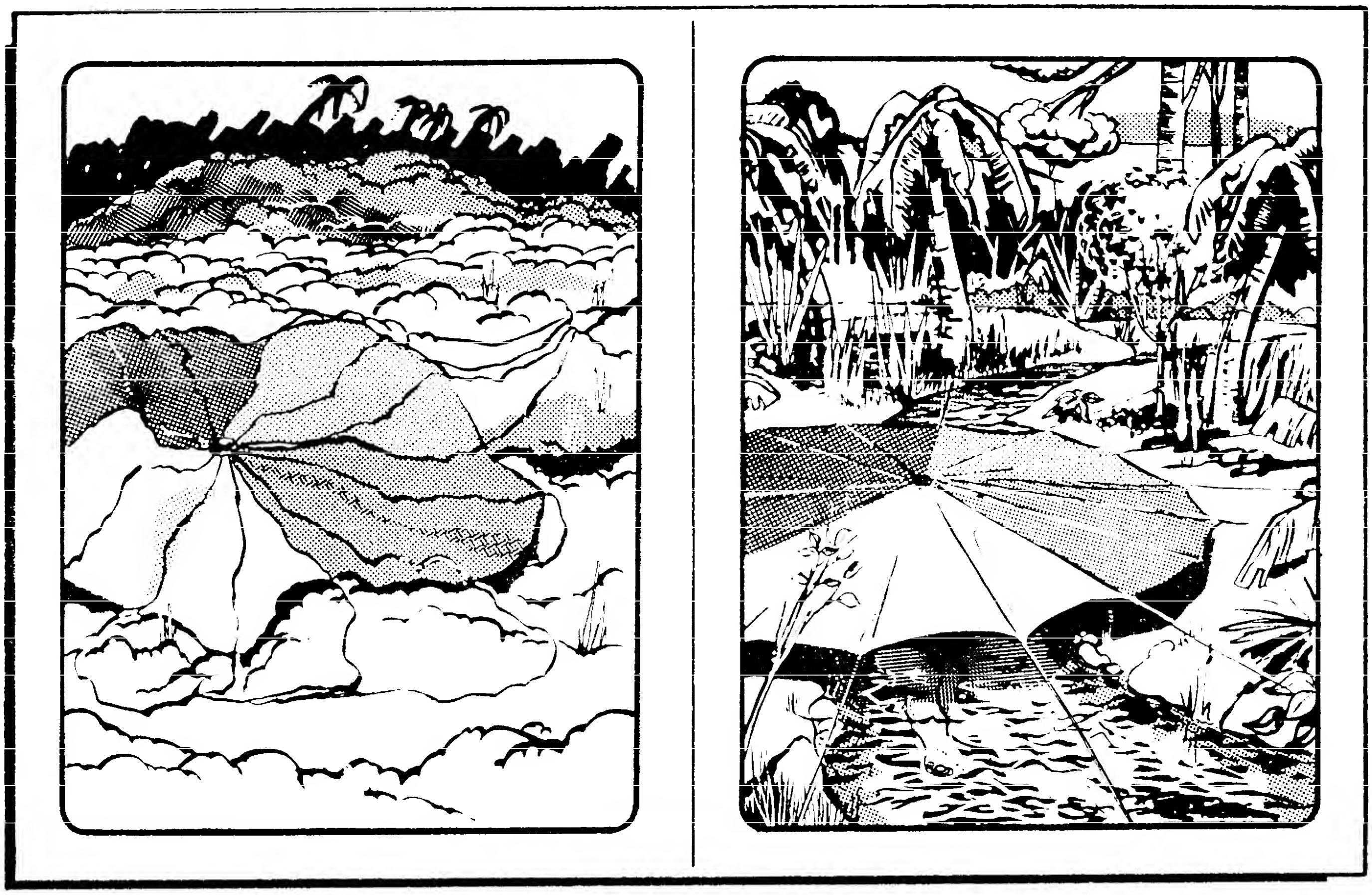


Figure 24-22. Chute Over Trees or Streams.

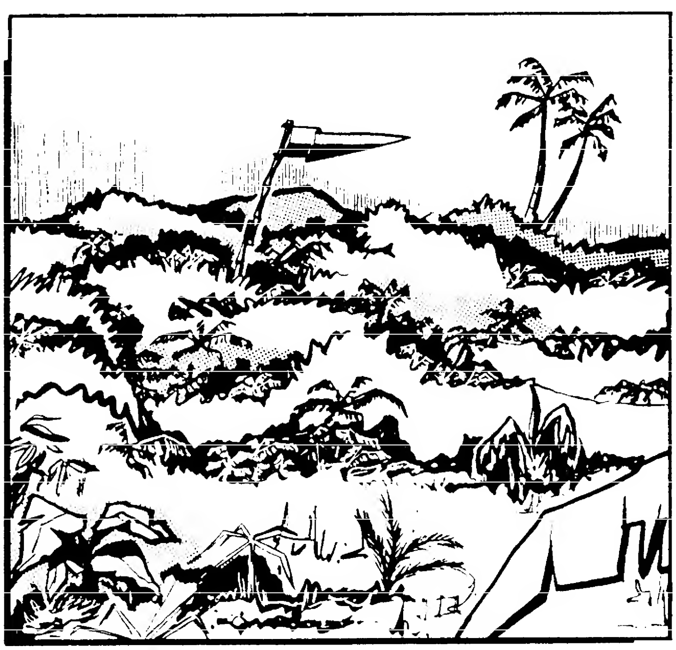


Figure 24-23. Pennants and Banners.

(3) When open areas are not available, survivors should stretch the chute over low trees and brush or across small streams (figures 24-22 and 24-23).

f. Shadow Signals. If no other means are available, survivors may have to construct mounds which will use the Sun to cast shadows. These mounds should be constructed in one of the international distress patterns. Brush, foliage, rocks, or snowblocks may be used to cast shadows. To be effective, these shadow signals must be oriented to the Sun to produce the best shadow. In areas close to the Equator, a north-south line gives a shadow at any time except noon. Areas farther north or south require the use of an east-west line or some point of the compass in between to give the best results.

g. Acknowledgements:

(1) Rescue personnel will normally inform the survivors they have been sighted by:

(a) Flying low with landing lights on (figure 24-24), and (or) rocking the wings.

(b) Emergency radio.

(2) Figure 24-25 depicts the standard body signals which can be used if electronic signaling devices are not available.

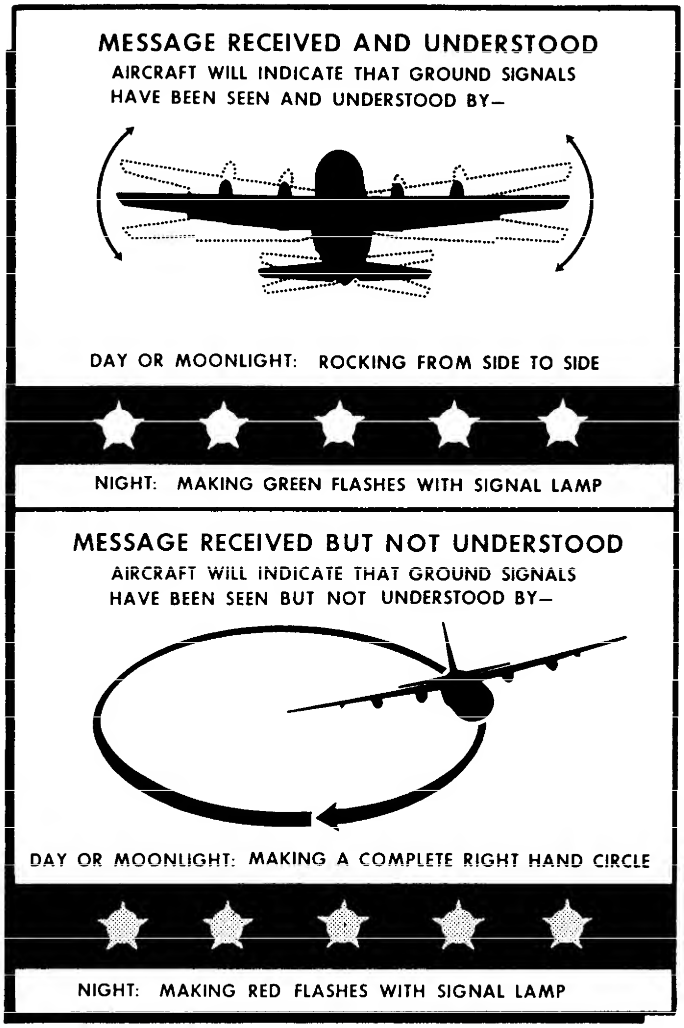


Figure 24-24. Standard Aircraft Acknowledgements.

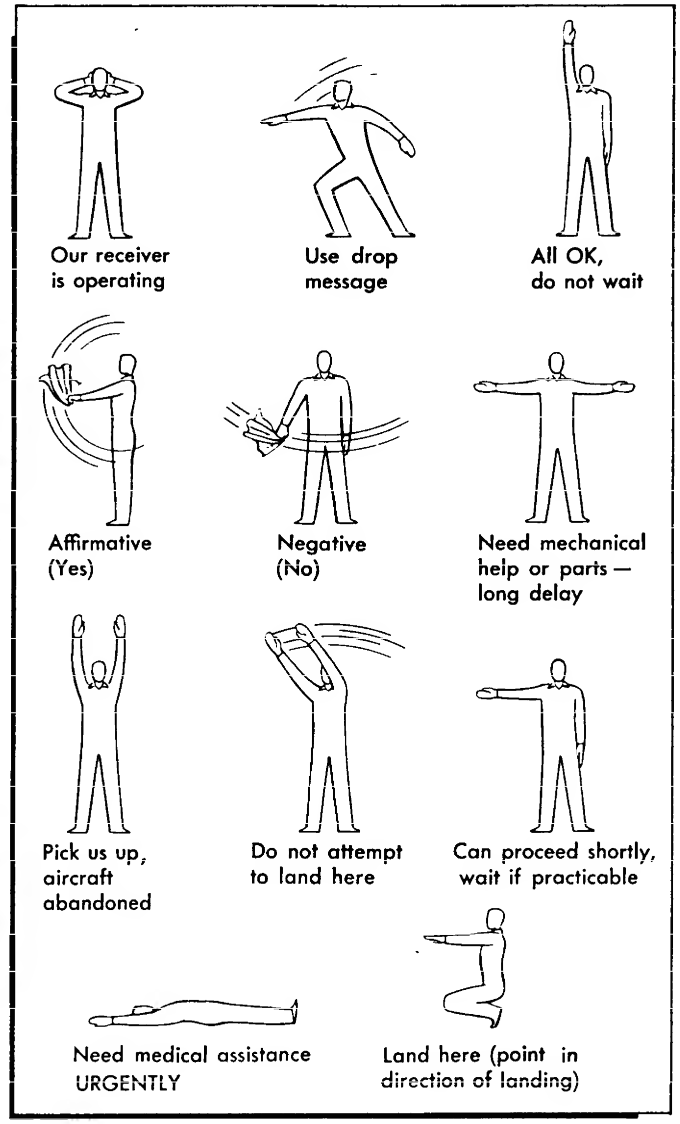


Figure 24-25. Close-In Visual Signals.

Chapter 25

RECOVERY PRINCIPLES

25-1. Introduction:

a. Receipt of a distress call sets a highly trained and well-equipped organization into operation; however, prompt and safe recovery is by no means ensured. The success of the rescue effort depends on many factors. Such factors as the availability of rescue forces, the proximity of enemy forces, and weather conditions can affect the success of the rescue. Above all, the survivors' knowledge of what to do in the rescue effort may make the difference between success and failure (figure 25-1).

b. The role of survivors in effecting their rescue changes continuously as aircraft and rescue equipment become more sophisticated. The probability of a downed aircrew member applying long-term survival training concepts under noncombat conditions continues to decrease while increasing under combat conditions.

c. There are several independent organizations engaged in search and rescue (SAR) operations or influencing the SAR system. The organizations may be international, federal, state, county, or local governmental, commercial, or private organizations. Survivors are responsible for being familiar with procedures used by international SAR systems in order to assist in rescue efforts. Some international organizations are:

(1) International Civil Aviation Organization (ICAO).

(2) Intergovernmental Maritime Consultive Organization (IMCO).

(3) Automated Mutual-Assistance Vessel Rescue (AMVER) System.

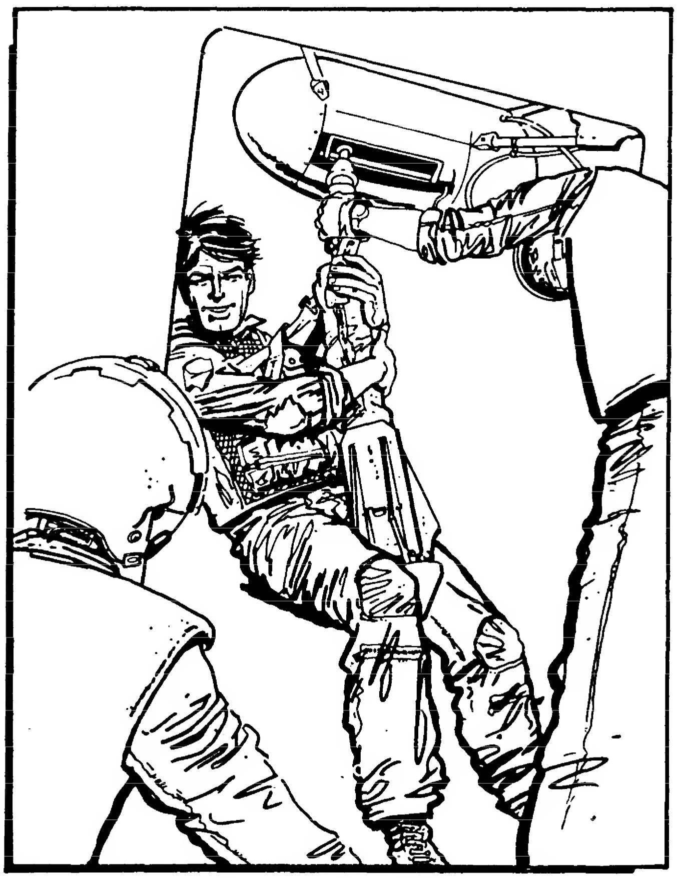


Figure 25-1. Recovery.

25-2. National Search and Rescue (SAR) Plan:

a. The National SAR Plan is implemented the instant an aircraft is known to be down. There are three primary SAR regions; they are the Inland Region, the Maritime Region, and the Overseas Region.

b. The Air Force is the SAR coordinator for the Inland Region, which encompasses the continental United States. The Coast Guard is the SAR coordinator for the Maritime Region, which includes the Carribean Area and Hawaii. The Third National Region is the Overseas Region. The Secretary of Defense designates certain Defense Department officers as United Commanders of specified areas where US Forces are operating. Wherever such commands are established, the Unified Commander is the Regional SAR Coordinator. Overseas regions are normally served by the Joint Rescue Coordination Center, operated under the Unified Action Armed Forces. Under the terms of the National SAR Plan, the "inland" area of Alaska is considered a part of the Overseas Region.

c. The National SAR Manual, Air Force Manual 64-2, provides a long-range rescue plan which personnel should study for additional information.

25-3. Survivors' Responsibilities:

a. The survivors' responsibilities begin at the onset of the emergency, with the dispatching of an immediate radio message. The radio message should include position, course, altitude, groundspeed, and actions planned. This information is essential for initiating efficient recovery operations.

b. Once recovery operations have been initiated, survivors have a continuing responsibility to furnish information. Both ground and radio signals should be immediate considerations.

c. If a group of survivors should become separated, each group member should, when contacted by rescue forces, provide information surrounding the dispersal of the group.

d. The greatest responsibility of aircrew members is to follow all instructions to the letter. The intelligence officer will brief aircrew members on procedures for tactical situations. These instructions must be followed

explicitly since it could mean the difference between life and death. When rescue personnel tell the survivor to unhook from the raft—it should be done immediately! If instructions are not followed, survivors could be responsible for causing their own death and (or) the death of rescue personnel.

25-4. Recovery Site:

a. Consideration must be given to a recovery site. The survivor's major considerations are the type of recovery vehicle carrying out the recovery and the effects of the weather and terrain on the rescue aircraft, such as updrafts and downdrafts, heat, wind, etc. Survivors should try to pick the highest terrain possible in the immediate area for pickup. When locating this rescue site, they should watch for obstacles such as trees, cliffs, etc., which could limit the aircraft's ability to maneuver. Overhangs, cliffs, or sides of steep slopes should be avoided. Such terrain features restrict the approach and maneuverability of the rescue vehicle and require an increase in rescue time.

b. Even though survivors should select a recovery site, it is the ultimate responsibility of rescue personnel to decide if the selected site is suitable.

25-5. Recovery Procedures:

a. Knowing Current Procedures. Since procedures involving recovery vary with changes in equipment and rescue capability, survivors must always know the current procedures and techniques. This is particularly true of the procedures used for wartime recovery, which are in AFR 64-3.

(1) In deciding whether or not supplies should be dropped, rescue forces consider such factors as the relative locations of the distress site to rescue unit bases, the lapse expected before rescue is initiated, and the danger of exposure. If a delay is expected, supplies are usually dropped to survivors to help sustain and protect them while they await rescue. The mobility of survivors on the land generally makes it possible to recover equipment dropped some distance away, but airdrops at sea must be accurate.

(2) Aircraft with internal aerial delivery systems, such as the HC-130, are the most suitable for delivery of supplies to survivors. Aircraft having bomb bays or exterior racks capable of carrying droppable containers or packages of survival requisites are the next most suitable for dropping supplies. However, these aircraft are not always available for supply dropping operations, so aircraft not specifically designed for this function may have to be used.

b. Rescue by Helicopter:

(1) Helicopters make rescues by landing or hoisting. Landings are usually required at high altitudes due to limitations of helicopter power for maintaining a hover. Hoist recovery is the preferred method for effecting a water rescue. Helicopter landings are made for all rescues when a suitable landing site is available, and danger from enemy forces is not a problem. Hovering the helicopters and hoisting the survivor aboard requires

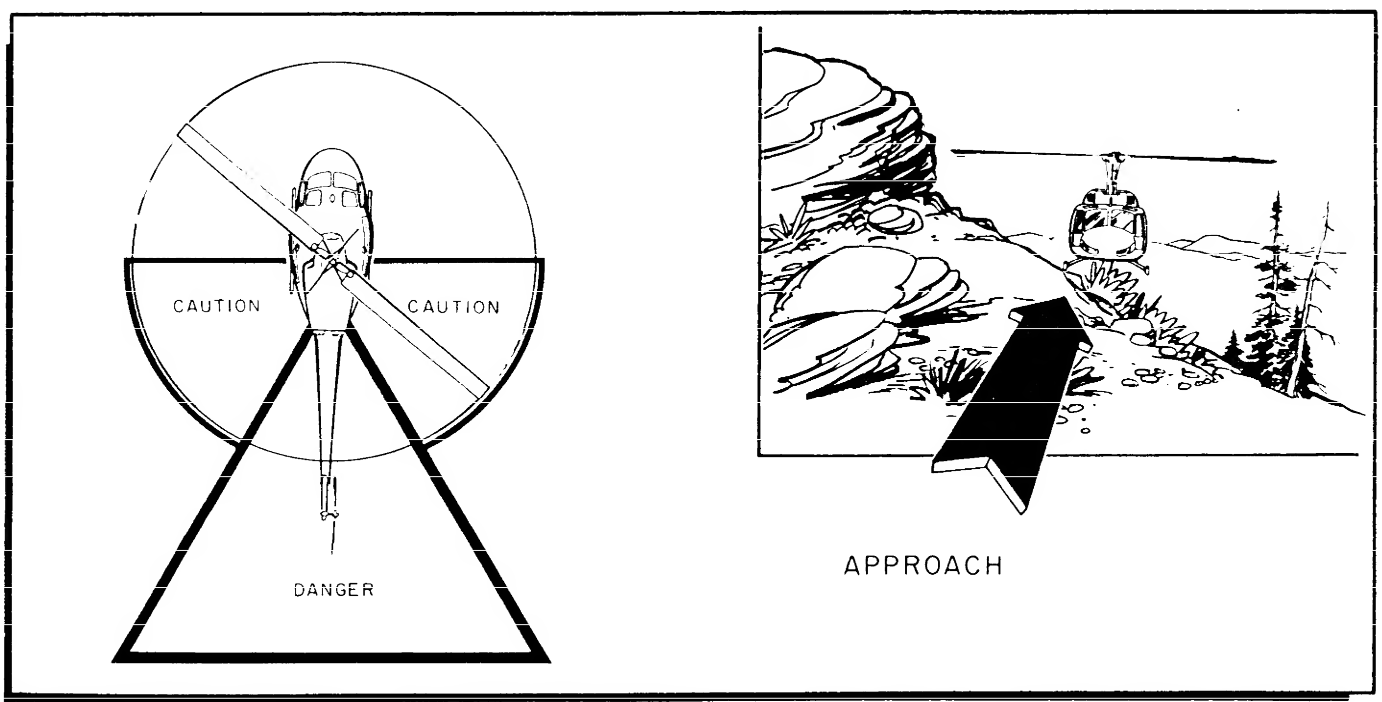


Figure 25-2. Approaching Helicopter.

more helicopter power than landing and presents a hazard to both the aircraft and the survivor. There is a danger if helicopters are operated close to collapsed parachutes. Parachute inflation by rotor downwash can cause the parachute to be sucked into the rotor blades of the helicopter.

(2) After landing, a crewmember will usually depart the aircraft. If for some reason this cannot be done, as in combat, the survivor should approach the helicopter from the 3 o'clock to 9 o'clock position relative to the nose of the helicopter and follow instructions (figure 25-2).

c. Rescue by Fixed-Wing Aircraft on Land:

(1) The most significant role played by fixed-wing aircraft in rescue operations is providing immediate assistance to survivors and serving as the "eyes" of approaching rescue units. This is done by pinpointing the survivors' position, orbiting the survivors, and dropping survival equipment. This type operation improves the morale of the survivors, fixes the survivors' location to prevent additional searching, and saves valuable time in getting the pickup unit on the scene.

(2) The role of fixed-wing aircraft in actually performing a rescue is limited to instances where there is a suitable runway near the survivor or where the aircraft is designed to operate from rough and improvised strips. Fixed-wing aircraft rescues have often been made in extremely cold climates where the aircraft have either used frozen lakes or rivers as runways or, when fitted with skis, have operated from snow-covered surfaces and glaciers. However, landing in unknown terrain under what appears to be ideal conditions is extremely hazardous.

d. Rescue by Ship:

(1) When a distress craft or survivors are a considerable distance from shore, rescue will normally be by long-range ships (specialized SAR ships, warships, or merchant ships). The rescue methods used by these ships vary considerably according to their displacement and whether the rescue is made in midocean or close to land. Weather, tides, currents, sea conditions, shallow water, reefs, daylight, or darkness may be important factors.

(2) Although it appears obvious that a marine craft should be used for rescue operations, it may be advisable to initiate an alternate method of recovery. For example, helicopters may be used to evacuate survivors picked up by marine craft in order to speed their delivery to an emergency care center.

(3) Removal of survivors from the water, liferafts, lifeboats, or other vessels to the safety of the rescue vessel deck may be the most difficult phase of a maritime search and rescue mission. In most cases, survivors will have to be assisted aboard. For this reason, all SAR vessels are usually equipped and prepared to lift survivors from the water without help from the survivors. There are numerous methods for rescuing survivors which may be used by SAR vessels. The most commonly used methods are listed in this chapter and are generally grouped as rescue of survivors in the water and rescue of survivors directly from their distressed vessel.

(a) When rescuing people from water, the following methods are generally used:

-1. Ship alongside/swimmer.
-2. Ship alongside/line thrower.
-3. Ship alongside/small boat.
-4. Ship circle/trail line.

(b) The most commonly used methods for rescuing personnel who are aboard distressed vessels are:

-1. Ship to ship/direct.
-2. Ship to ship/raft haul.
-3. Ship to ship/raft drift.
-4. Ship to ship/small boat.
-5. Ship to ship/haulaway line.

e. Rescue by Boat:

(1) When survivors are located on lakes, sheltered waters, rivers, or coastal areas, rescue will often be made by fast boats of limited range based close to the survivors or by private boats operating in the vicinity.

(2) Rescue boats are usually small and may not be able to take all survivors on board at one time; therefore, a sufficient number of boats to offset the rescue should be dispatched to the distress scene. When this is not possible, each boat should deploy its rafts so that those survivors who cannot be taken aboard immediately can be towed ashore or kept afloat while they are waiting. The boat crew should make sure any survivors who must be left behind are made as secure as circumstances permit.

(3) Assistance to an aircraft that has crashed or ditched on the water will usually consist of transferring personnel from plane to boat and picking up survivors from the water or liferafts. It may also include towing of an aircraft which is disabled on the water.

f. Coordinated Helicopter/Boat Rescues:

(1) Occasionally, boats and helicopters will be dispatched for a rescue operation. Generally the first rescue unit to arrive in the vicinity of the survivors will attempt the first rescue.

(2) If the helicopter arrives first, the boat will take a position upwind of the helicopter in the 2 o'clock position at a safe distance and stand by as a backup during the rescue attempt.

(3) If the helicopter must abort the rescue attempt, the pilot will depart the immediate area of the survivor and signal for the boat to move in and make its rescue attempt. Additionally, the helicopters may turn out the anticollision rotating beacon to indicate they require

boat assistance or are unable to complete the rescue. In certain operations where helicopter and boat coordinated rescue can be foreseen, specific signals should be prearranged.

(4) If the boat arrives first and makes the rescue, it will transfer the survivor to the helicopter to effect a rapid delivery to medical facilities.

25-6. Pickup Devices:

a. Assistance. When rescue forces are in the immediate area of survivors, they will, if conditions permit, deploy pararescue personnel to assist the survivors. Unfortunately, conditions may not always permit this, so survivors should know how to use different types of pickup devices.

b. Common Factors. Some common factors concerning all pickup devices are:

(1) The device should be allowed to ground to discharge static electricity before donning.

(2) To ensure stability, survivors should sit or kneel when donning a pickup device. Do not straddle the device.

(3) If no audio is available, survivors should visually signal the hoist operator when ready for lift-off— "thumbs up" or vigorously shake the cable from side to side.

(4) Most devices can be used as a sling (strop).

(5) Survivors must remember to follow all instructions provided by the rescue crew. When lifted to the door of the helicopter, survivors should not attempt to grab the door or assist the hoist operator in any way. They must not try to get out of the pickup device. The hoist operator will remove the device after the survivor is well inside the aircraft.

c. Rescue Sling. Before donning the rescue sling (strop), the survivor should face the drop cable and make sure the cable has touched the water or ground and lost its charge of static electricity.

(1) The most commonly accepted method for donning the rescue sling (strop) is the same as putting on a coat. After connecting the ring to form the sling (strop), the survivor's arms should be inserted one by one into the sling (strop) as it swings behind. The sling (strop) loop should be against the survivor's back with an arm around each side of the strop. The webbing under the metal ring can be held until tension is put on the cable. The survivor's hands may then be interlocked and rested on the chest. This tends to lock the survivor into the sling (strop) as upward pressure is applied (figure 25-3).

(2) Another way to enter the strop is to grasp the strop with both hands and lift it over the head to bring it down under the arms and around the body. Regardless of the method used, the survivor should remember the webbing and metal hardware of the device should be directly in front of the face.

d. Basket. If a basket is used, it will probably be accompanied to the water or ground by a member of the helicopter crew. The crewmember will assist survivors into the basket. There are two types of baskets: The litter type in which the person lies flat, and the seat type that survivors enter and sit down in as they would in a chair (figure 25-4).

e. Forest Penetrator:

(1) The forest penetrator rescue seat is designed to make its way through interlacing tree branches and dense jungle growth. It can also be used in open terrain or over water. The device is equipped with three seats

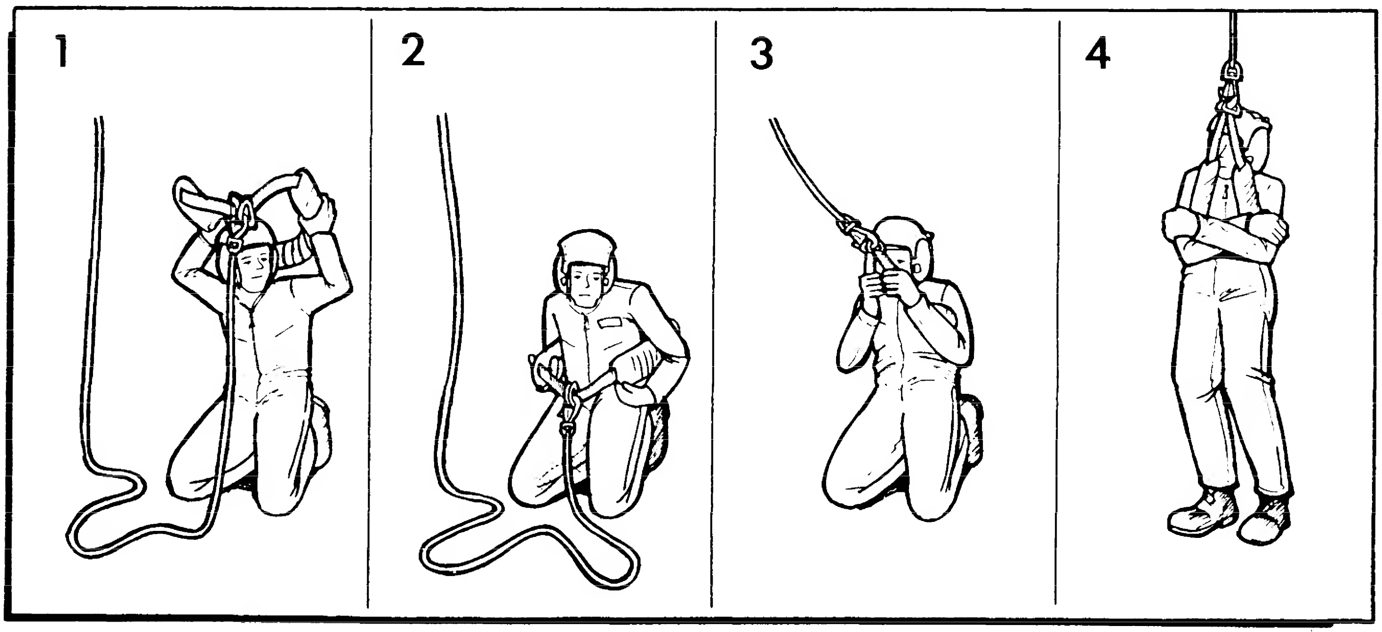


Figure 25-3. Horse Collar.

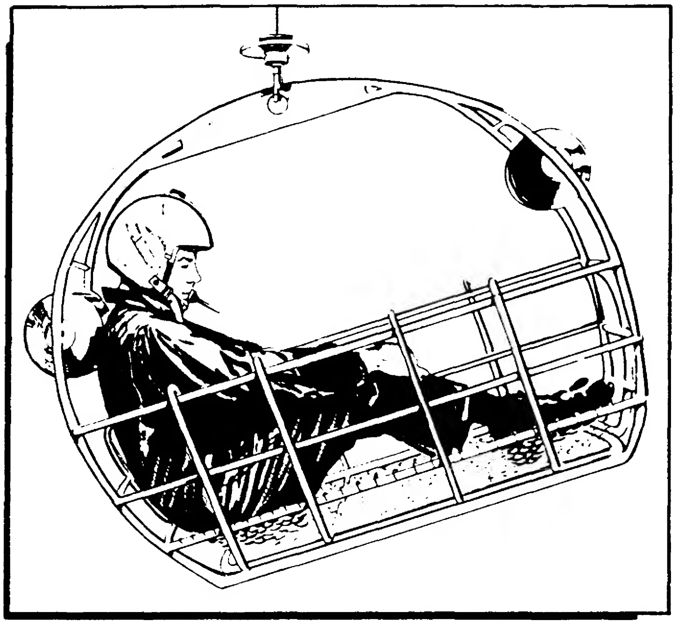


Figure 25-4. Basket.

which are spring-loaded in a folded position against the body or main shaft and must be pulled down to the locked position for use. On the main shaft of the tube, above the seats, there is a zippered fabric storage pouch for the safety (body) straps which are stowed when lowered to the survivor for a land pickup. The penetrator may also be equipped with a flotation collar. (NOTE: If the forest penetration is used for water pickup, it will be equipped with the flotation collar which enables the device to float with the upper one-third (approximately) of the device protruding above the water. Additionally, for water pickups, one strap will be removed from the stowed position, and one seat will be locked in the down position to assist the survivor in using the penetrator.)

(2) The safety strap is pulled from the storage pouch and placed around the body to hold the person on the penetrator seat. The strap should not be unhooked unless there is no other way to fasten it around the body. The survivor must make certain the safety strap does not become fouled in the hoist cable. After the strap is in place, the seat should be pulled down sharply to engage the hook which holds it in the extended position. The survivor can then place the seat between the legs. Then the survivor should pull the safety strap as tight as possible ensuring the device fits snugly against the body. The survivor must always keep the arms down, elbows locked against the body, and not attempt to grab the cable or weighted snap link above the device. After making certain the body is not entangled in the hoist cable, the signal to be lifted can be given (figure 25-5).

(3) In a combat area, under fire, survivors may be lifted out of the area with the cable suspended before

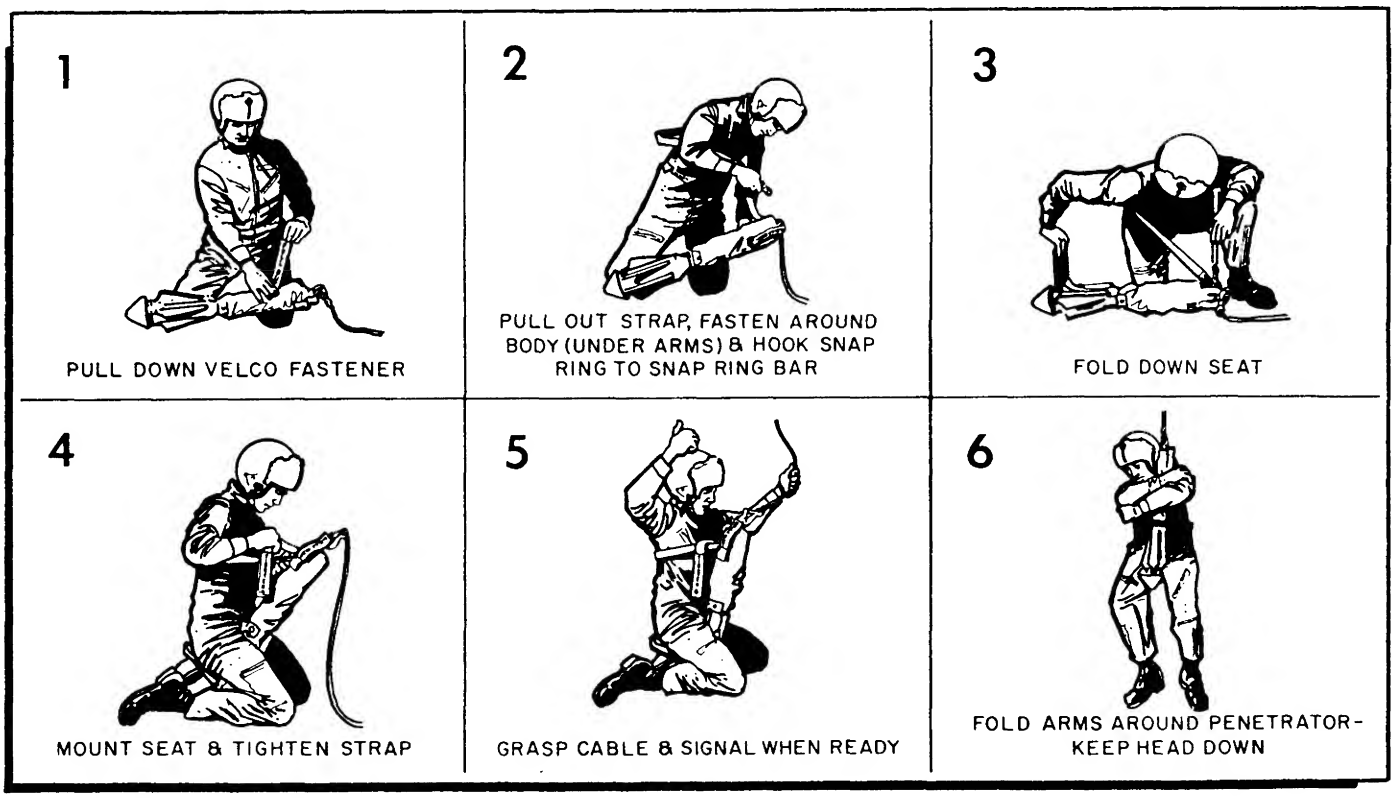


Figure 25-5. Forest Penetrator.

being brought into the helicopter. It is important to be correctly and securely positioned on the pickup device. The seat should always be held tightly against the crotch to prevent injury when slack in the cable is taken up. The hands should be kept below and away from the swivel on the cable with the arms around the body of the penetrator. Survivors should keep their head close to the body of the penetrator so that tree branches or other obstructions will not come between the body and the hoist cable.

(4) When survivors reach a position level with the helicopter door, the hoist operator will turn them so they face away from the helicopter and then pull them inside. The crewmember will disconnect the survivors from the penetrator once the device is safely inside the helicopter.

(5) The forest penetrator is designed to lift as many as three persons. When two or three survivors are picked up, heads should be kept tucked in and each individual's safety strap drawn tight. The penetrator can be used to lower a paramedic or crewmember to assist injured personnel, and both (survivor and paramedic) can be hoisted to the helicopter. If the forest penetrator

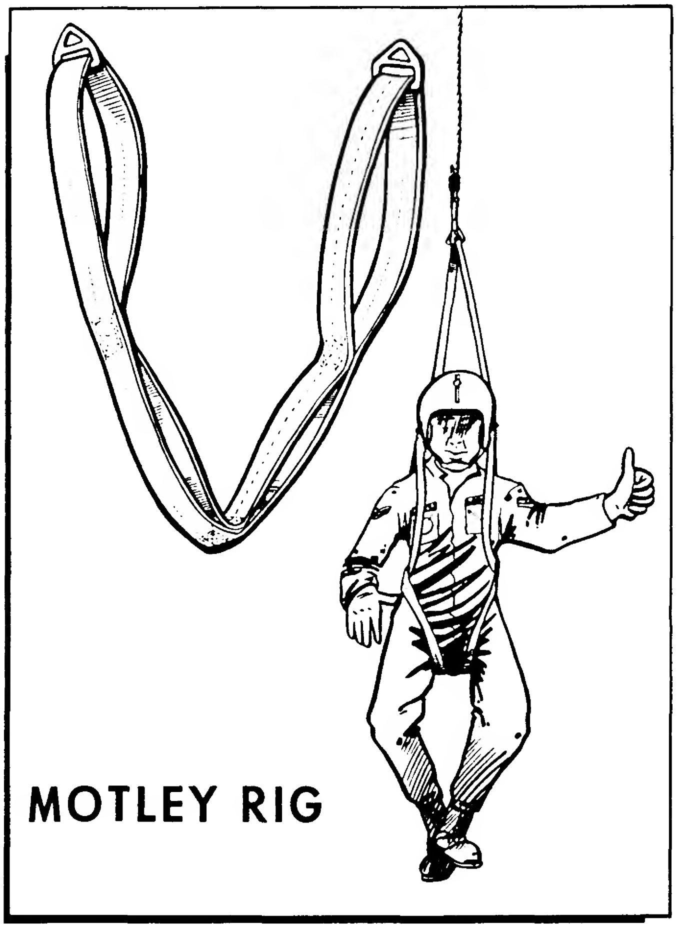


Figure 25-6. Motley Rig.

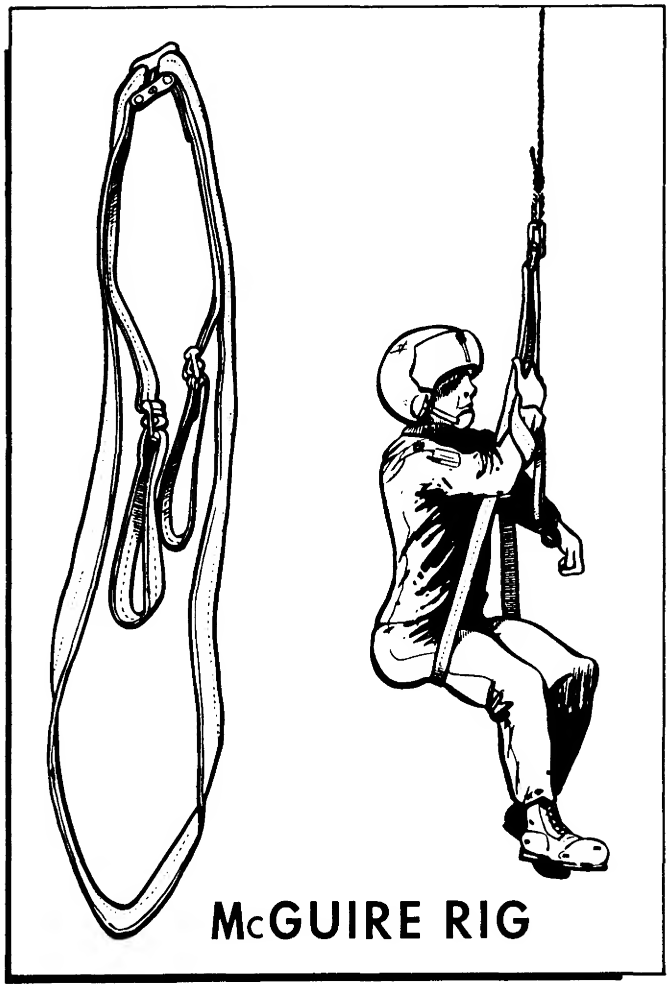


Figure 25-7. McGuire Rig.

seat blades have been lowered in a tree area, and if for any reason the pickup cannot be made, the blades should be returned to the folded position to prevent possible hangup on tree limbs or other objects while the device is being retracted.

(6) With all types of devices, it is necessary to watch the device as it is lowered. The devices weigh about 23 pounds. If the device were to hit a survivor, it could cause a serious injury or death.

f. Other Devices. There are other devices which could be used to pick up survivors. Some of them are the Motley and McGuire rigs (figures 25-6 and 25-7), the Swiss Seat and Stabo rig (figures 25-8 and 25-9), and the Rope Ladder (figure 25-10).

(1) Motley and McGuire Rigs. These devices may be carried by Army helicopters either designated as the recovery aircraft in assault or for use to insert or extract special ground forces. The device is normally packed in a weighted canvas container and dropped by rope. The device is dropped to the survivor, who is allowed time

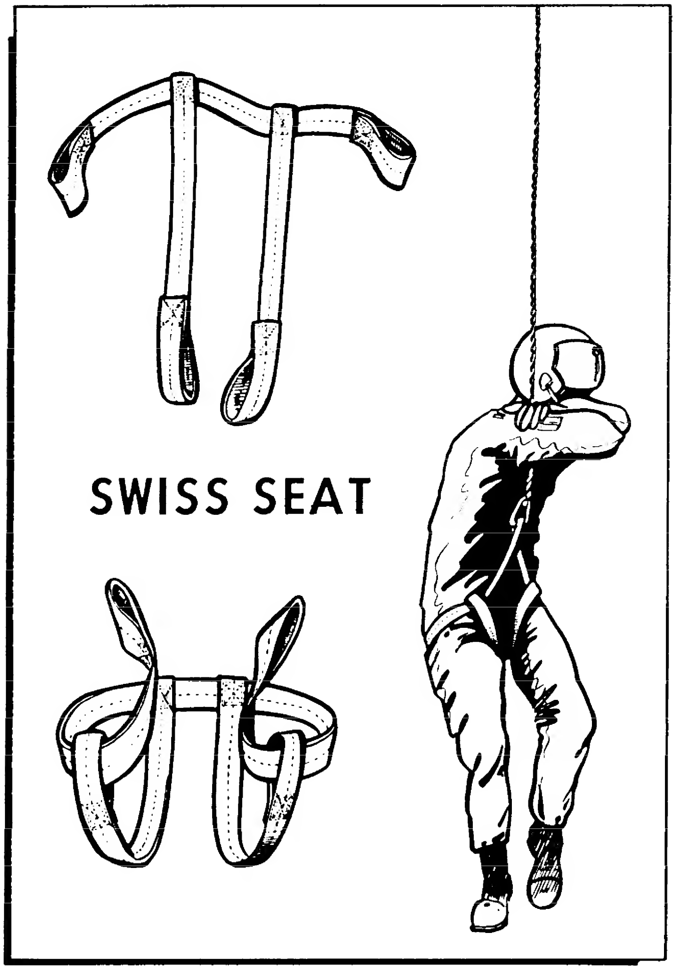


Figure 25-8. Swiss Seat.

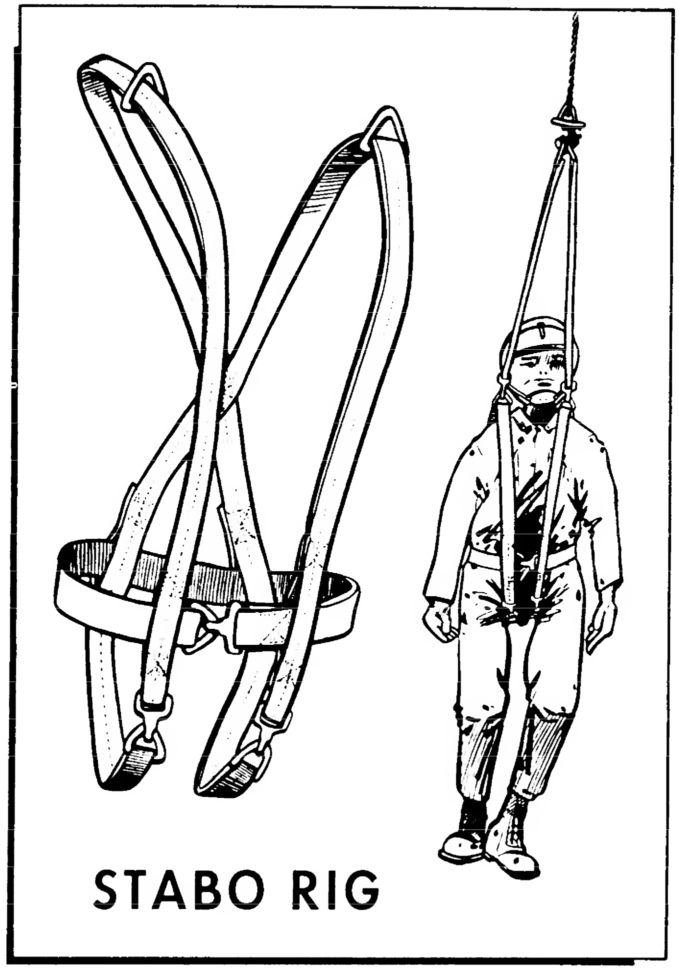


Figure 25-9. Stabo Rig.

for donning. The helicopter then returns trailing a rope which is then fastened to the device for pickup. Generally, the survivor is not hoisted into the helicopter; therefore, all safety straps should be securely fastened.

(2) Swiss Seat and Stabo Rig (figures 25-8 and 25-9). These devices are carried by special ground forces who may require instant extraction by helicopter. Special ground forces put their devices on and wait for the helicopter to drop ropes which are snapped into the devices for rapid extraction. Although not normally carried aboard the aircraft, the Army helicopter may supply one of these devices to the survivor. Again, the survivor would not be hoisted into the helicopter.

(3) Rope Ladder. This device is used primarily by the Army and special ground forces. If this device is used, it should be approached from the side and not the front. The survivor should climb up a few rungs, sit down on a rung, intertwine the body with rungs (figure 25-10). The survivor should not try to climb up the ladder and into the helicopter.

25-7. Preparations for Open Seas Recovery:

a. On sighting rescue craft approaching for pickup, (boat, ship, conventional aircraft, or helicopter), survivors must quickly clear any lines (fishing lines, desalting kit lines, etc.) or other gear which could cause entanglement during rescue. All loose items should be secured in the raft. Canopies and sails should be taken down to ensure a safer pickup. After all items are secure, the survivor should put on the helmet (if available). The life preserver should be fully inflated with the oral valve locking nut tight against the mouthpiece. Survivors should remain in the raft, unless otherwise instructed, and disengage all gear except the preservers. If possible, rescue personnel will be lowered into the water to assist survivors. The survivors should remember to follow all instructions given by rescue personnel.

b. If helicopter recovery is unassisted, the survivor will be expected to do the following before to pickup:

(1) Secure all loose equipment in raft, accessory bag, or in pockets.

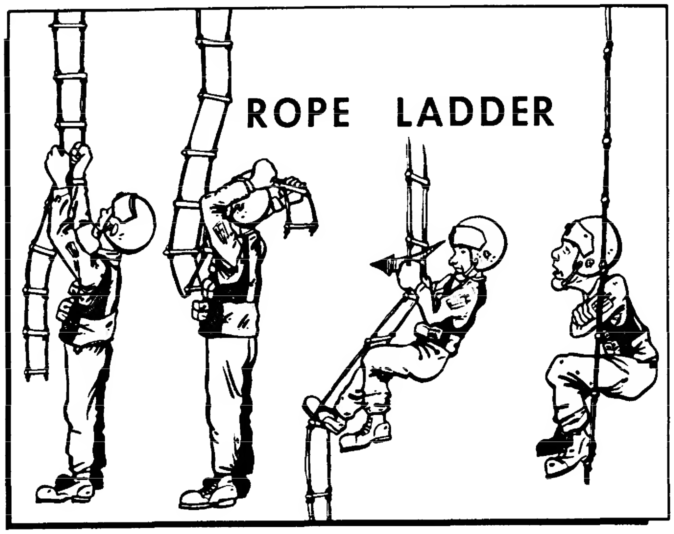


Figure 25-10. Rope Ladder.

(2) Deploy sea anchor, stability bags, and accessory bag.

(3) Partially deflate raft and fill with water.

(4) Unsnap survival kit container from parachute harness.

(5) Grasp raft handhold and roll out of raft.

(6) Allow recovery device and (or) cable to ground out on water surface.

(7) Maintain handhold until recovery device is in the other hand.

(8) Mount recovery device (avoid raft lanyard entanglement).

(9) Signal hoist operator for pickup.